PB86-192044

National Air Quality and Emissions Trends Report, 1984

(U.S.) Environmental Protection Agency
Research Triangle Park, NC

Mar 86

U.S. Department of Commerce
National Technical Information Service
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PB86-192044

United States
Environmental Protection
Agency

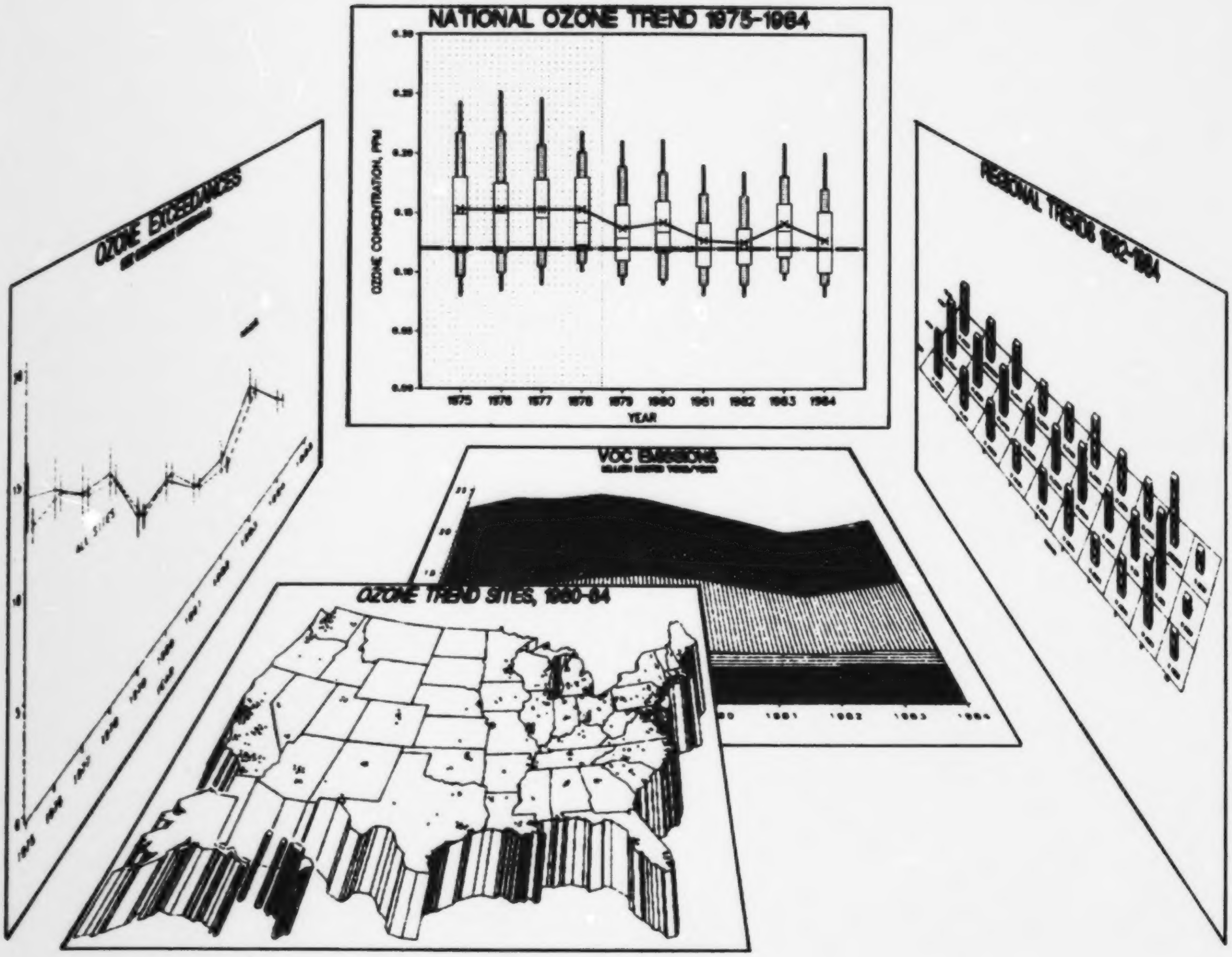
Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EPA-450/4-86-001
April 1986

Air

EPA

National Air Quality and Emissions Trends Report, 1984



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(Please read Instructions on the reverse before completing)

1. REPORT NO.
EPA 450/4-86-001

2.

3. RECIPIENT'S ACCESSION NO.
PB86 192044/AS

4. TITLE AND SUBTITLE
National Air Quality and Emissions Trends Report, 1984

5. REPORT DATE
March 1986

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S) W. F. Hunt, Jr., (Editor), T. C. Curran, R. B. Faoro, N. H. Frank, W. Freas, C. Mann, R. E. Neligan, S. Sleva, N. Berg, D. Lutz, G. Manire, and D. Shipman

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS

13. TYPE OF REPORT AND PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
The computer graphics were prepared by K. Nelson and the typing by H. Hinton and J. Harris.

16. ABSTRACT

This report presents national and regional trends in air quality from 1975 through 1984 for total suspended particulate, sulfur dioxide, carbon monoxide, nitrogen dioxide, ozone and lead. Air pollution trends were also examined for the 5-year period (1980-84) to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality. Both national and regional trends in each of the major pollutants are examined, as well as complimentary air quality trends in 1984. National air quality trends are also presented for both the National Air Monitoring Sites (NAMS) and other site categories. In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements.

This report also includes a section, Air Quality Levels in Standard Metropolitan Statistical Areas (SMSA's). Its purpose is to provide interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all SMSA's with populations exceeding 500,000 for the years 1982, 1983 and 1984.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution Trends Emission Trends Carbon Monoxide Nitrogen Dioxide Ozone Sulfur Dioxide Total Suspended Particulates Lead Air Pollution Standard Metropolitan Statistical Area (SMSA) Air Quality Statistics National Air Monitoring Stations (NAMS)		

18. DISTRIBUTION STATEMENT Release Unlimited	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

*U.S. GOVERNMENT PRINTING OFFICE: 1986--625-040/21522

EPA-450/4-86-001

NATIONAL AIR QUALITY AND EMISSIONS
TRENDS REPORT, 1984

U.S. Environmental Protection Agency
Office of Air and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

DISCLAIMER

This report has been reviewed by the Office of Air Quality Planning and Standards, Environmental Protection Agency, and approved for publication. Mention of trade names or commercial products is not intended to constitute endorsement or recommendation for use.

PREFACE

This is the twelfth annual report of air pollution trends issued by the Monitoring and Data Analysis Division of the U. S. Environmental Protection Agency. The report is directed toward both the technical air pollution audience and the interested general public. The Division solicits comments on this report and welcomes suggestions on our trend techniques, interpretations, conclusions, and methods of presentation. Please forward any response to William F. Hunt, Jr., (MD-14) U. S. Environmental Protection Agency, Monitoring and Data Analysis Division, Research Triangle Park, N. C. 27711.

The Monitoring and Data Analysis Division would like to acknowledge William F. Hunt, Jr., for the overall management, coordination, and direction given in assembling this report. Special mention should also be given to Helen Hinton and Jo Harris for typing the report.

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Section 3 - Thomas C. Curran, Robert B. Faoro, Neil H. Frank, and Warren Freas
Section 4 - William F. Hunt, Jr. and Robert B. Faoro
Section 5 - Stan Sleva, Neil Berg, David Lutz, George Manire, and Dennis Shipman

Also deserving special thanks are Karen Nelson for assembling the air quality data base and preparing the computer graphics, Chuck Mann and Jake Summers for the emission trend analyses, George Duggan for the population exposure estimates, and David Henderson and Coe Owen of EPA Region IX for providing us with their computer software to generate the air quality maps of the United States used in this report.

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NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, 1984

EXECUTIVE SUMMARY

NATIONAL AIR QUALITY AND EMISSIONS TRENDS REPORT, 1984

1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

While considerable progress has been made controlling air pollution, it still remains a serious public health problem. In order to protect the public health and welfare, the U.S. Environmental Protection Agency (EPA) has promulgated National Ambient Air Quality Standards (NAAQS). Primary standards protect the public health, while secondary standards protect the public welfare, as measured by the effects of air pollution on vegetation, materials and visibility. This report will focus on comparisons to the primary standards to examine both changes in air pollution levels over time, as well as current air pollution status.

In 1984, 79.2 million people were living in counties with measured air quality levels, that violated the NAAQS for ozone (O_3) (Figure 1-1). This compares with 61.3 million people for carbon monoxide (CO), 32.6 million people for total suspended particulate (TSP), 7.5 million people for nitrogen dioxide (NO_2), 4.7 million people for lead (Pb) and 1.7 million people for sulfur dioxide (SO_2). While millions of people continue to breathe air that is in violation of the NAAQS, considerable progress is being made in reducing air pollution levels.

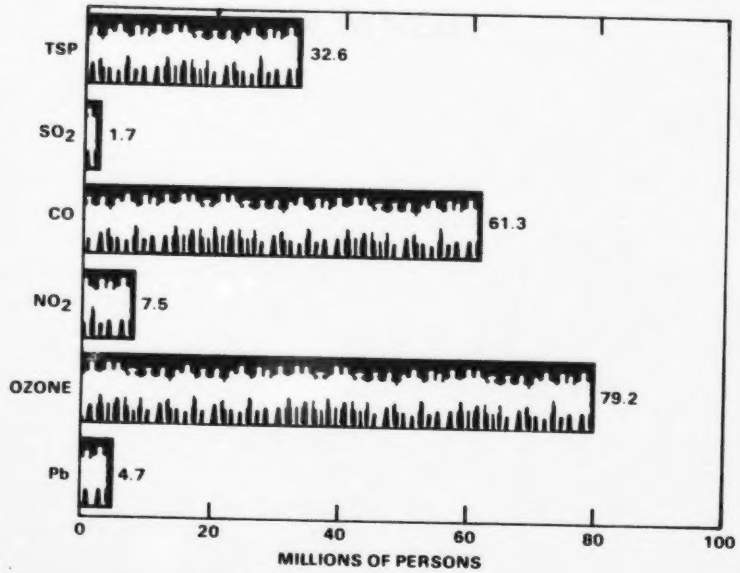


Figure 1-1. Number of persons living in counties with air quality levels above the primary National Ambient Air Quality Standards in 1984 (Based on 1980 population data).

Nationally, long-term 10-year (1975 through 1984) improvements can be seen for TSP, SO_2, CO, NO_2, O_3, and Pb. Similar improvements have been documented in earlier air quality trends reports,[1-11] issued by EPA. The trend in O_3 is complicated by a major drop in measured concentration levels which occurred between 1978 and 1979, largely due to a change in the O_3 measurement calibration procedure.[12] Therefore, special attention is given to the period after 1979, because the change in the calibration procedure is not an influence during this time.

The 10-year trend (1975-1984) is complemented with a more recent 5-year trend (1980-1984). The 5-year trend is being introduced in this report to increase the number of sites available for trend analysis. Future trends reports will focus on the post-1980 period to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality, with sites meeting uniform siting criteria and high standards of quality assurance. Nationally, improvements can be seen for all the pollutants during the 5-year period. Between 1983 and 1984, however, TSP, SO_2 and NO_2 showed slight increases, while CO showed a slight decline, Pb a more substantial decline, and O_3 declined from its 1983 level to the levels of 1981 and 1982.

The trends in ambient air quality, that follow, are presented as boxplots, which display the 5th, 10th, 25th, 50th (median), 75th, 90th and 95th percentiles of the data, as well as the composite average (Figure 1-2). The 5th, 10th and 25th percentiles depict the "cleaner" sites, while the 75th, 90th and 95th depict the dirtier sites and the median and average describe the "typical" sites. The use of the boxplots allow us to simultaneously compare trends in the "cleaner", "typical" and "dirtier" sites.

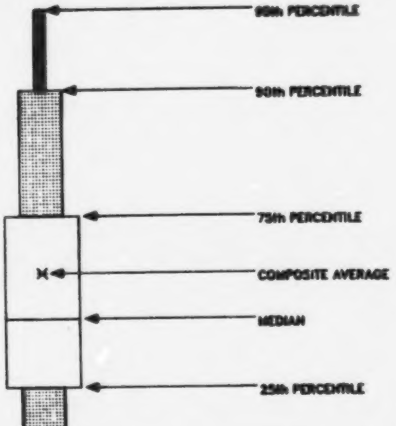


Figure 1-2. Illustrations of plotting conventions for boxplots.

All of the ambient air quality trend analyses are based on monitoring sites which recorded at least 8 of the 10 years of data in the period 1975 to 1984 or 4 out of 5 years in the period 1980 to 1984. Each year had to satisfy an annual data completeness criteria, which is discussed in Section 2.1, Data Base.

Finally, the Executive Summary also contains air quality maps of the United States to show at a glance how air quality varies among the 80 largest standard metropolitan statistical areas (SMSA). In each map, a spike is plotted at the city location on the map surface. This represents the highest pollutant concentration, recorded in 1984, corresponding to the appropriate air quality standard. Each spike is projected onto a backdrop facilitating comparison with the level of the standard. This also provides an east-west profile of concentration variability throughout the country.

1.2 MAJOR FINDINGS

Total Suspended Particulate (TSP) - Annual average TSP levels, measured at 1344 sites, decreased 20 percent between 1975 and 1984 (Figure 1-3). This corresponds to a 33 percent decrease in estimated particulate emissions for the same period (Figure 1-4). TSP air quality levels generally do not improve in direct proportion to estimated emissions reductions, because air quality levels are influenced by factors such as natural dust, reintrained street dust, construction activity, etc., which are not included in the emissions estimates. EPA has found that the TSP data collected during the years 1979-1981 may be biased high due to the glass fiber filter used during these years, and that most of the large apparent 2-year decrease in pollutant concentrations between 1981 and 1982 can be attributed to a change in these filters.[11,13,14] For this reason, the portion of the Figure 1-3 graph corresponding to 1979-1981 is stippled, indicating the uncertainty associated with these data. TSP decreased between 1982 and 1983, while rainfall increased. Then in 1984, the TSP levels increased 2 percent over the 1983 levels, following a return of rainfall to more normal levels and an increase in particulate emissions. The most recent 1984 annual geometric mean TSP concentration is plotted for the 80 largest SMSA(s) (Figure 1-5). The highest concentrations are generally found in the industrial Midwest and arid areas of the West. The east-west profile shows that levels above the current standard of 75 ug/m^3 can be found throughout the Nation.

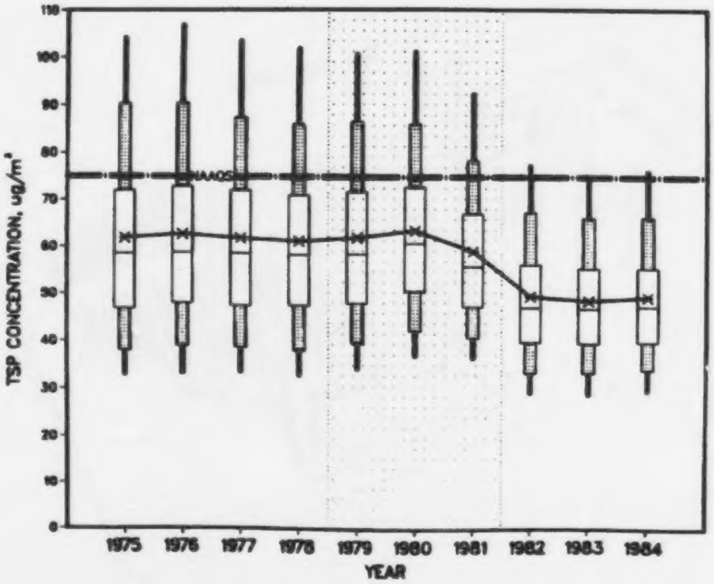


Figure 1-3. National boxplot trend in annual geometric mean TSP concentrations, 1975 - 1984.

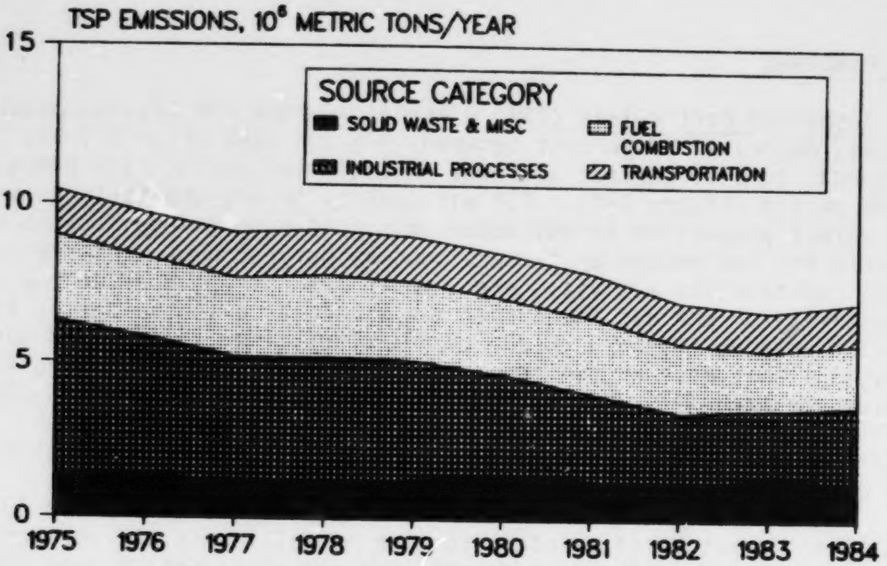


Figure 1-4. National trend in particulate emissions, 1975 - 1984.

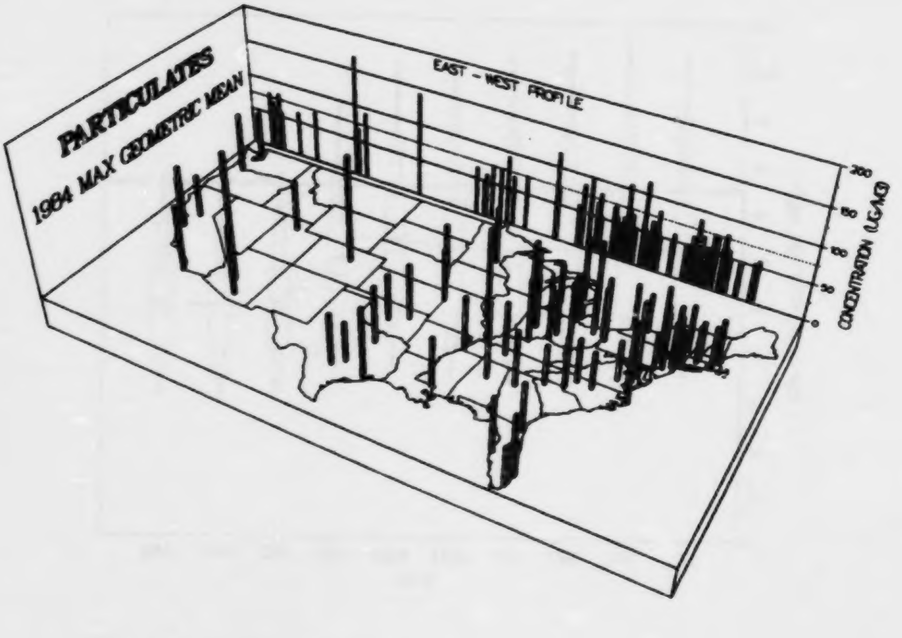

PARTICULATES
1984 MAX GEOMETRIC MEAN
EAST - WEST PROFILE
200
150
100
50
0
CONCENTRATION (UG/M3)

Figure 1-5. United States map of the highest annual geometric mean TSP concentration by SMSA, 1984.

Sulfur Dioxide (SO_2) - Annual average SO_2 levels measured at 229 sites with continuous SO_2 monitors decreased 36 percent from 1975 to 1984 (Figure 1-6). A comparable decrease of 41 percent was observed in the trend in the composite average of the second maximum 24-hour averages (Figure 1-7). An even greater improvement was observed in the estimated number of exceedances of the 24-hour standard, which decreased 93 percent (Figure 1-8). Correspondingly, there was a 16 percent drop in sulfur oxide emissions (Figure 1-9). The difference between emissions and air quality can be attributed to several factors. SO_2 monitors are mostly urban population-oriented and as such do not monitor many of the major emitters which tend to be located in more rural areas. The residential and commercial areas, where most monitors are located, have shown sulfur oxide emission decreases comparable to SO_2 air quality improvement. Between 1983 and 1984, nationwide average SO_2 levels increased 2 percent. The increase in ambient levels correspond to a 4 percent increase in sulfur oxide emissions, which reflects increased fuel consumption. The most recent 1984 annual arithmetic mean SO_2 is plotted for the 80 largest SMSA(s) (Figure 1-10). Among these large metropolitan areas, the higher concentrations are found in the heavily populated Midwest and Northeast. The peak SO_2 mean concentration occurs in Pittsburgh, PA at an individual site near a large steel complex. All other urban areas have lower ambient air quality concentrations, well within the current annual standard of 80 ug/m^3 (.03 ppm). Because this map only represents areas with population greater than one half million, it does not reflect air quality in the vicinity of smelters or large power plants in rural areas.

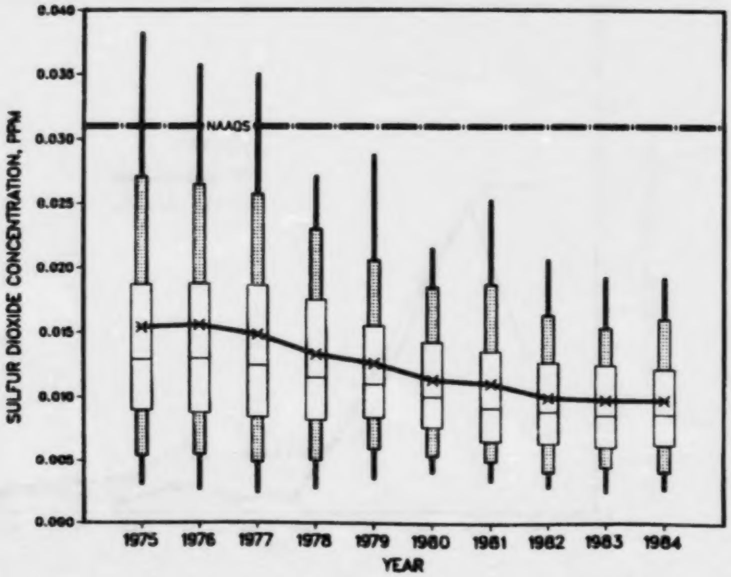


Figure 1-6. National boxplot trend in annual average SO_2 concentrations, 1975 - 1984.

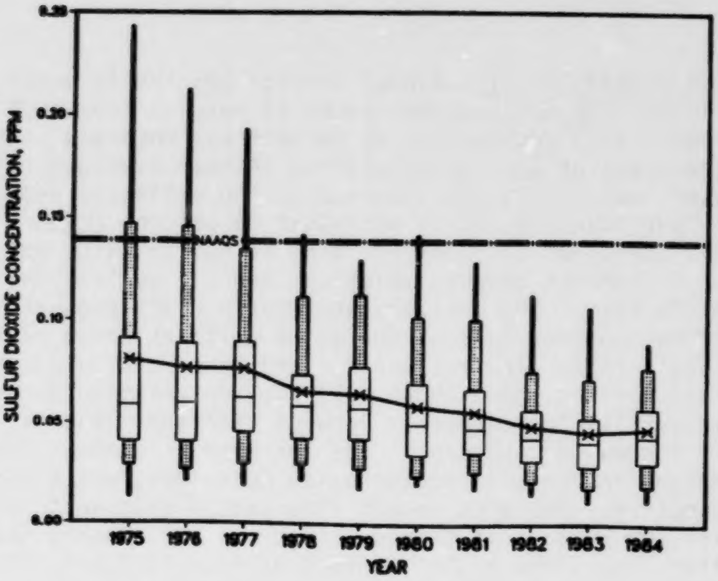


Figure 1-7. National boxplot trend in second highest 24-hour SO_2 concentrations, 1975 - 1984.

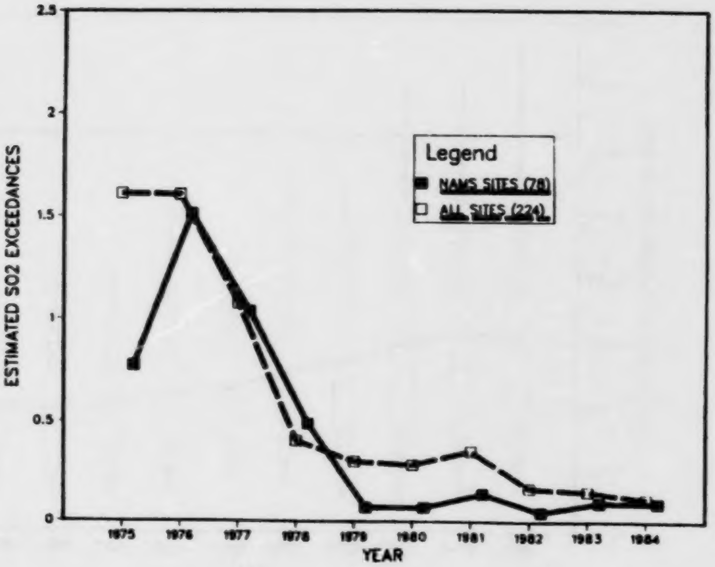


Figure 1-8. National trend in the composite average of the estimated number of exceedances of the 24-hour SO_2 NAAQS, 1975 - 1984.

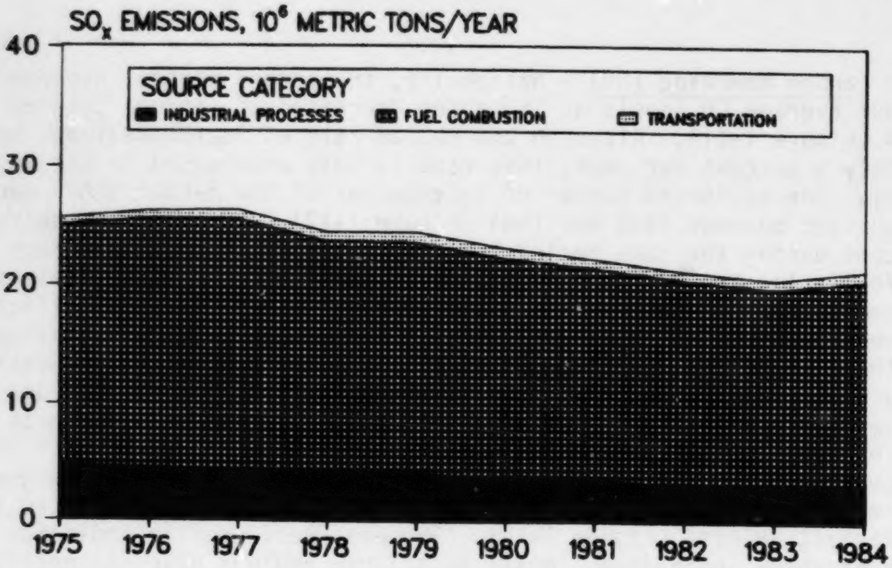


Figure 1-9. National trend in sulfur oxide emissions, 1975 - 1984.

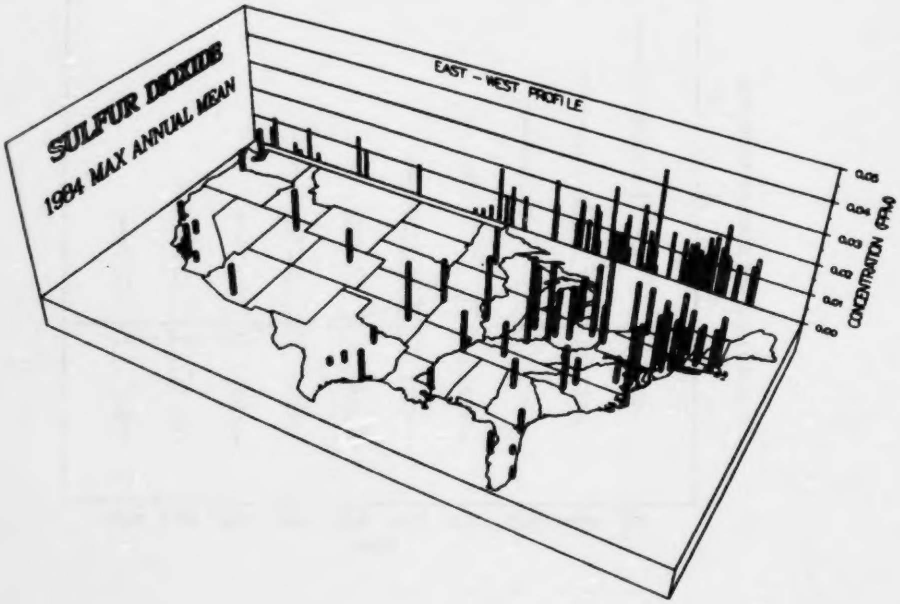

SULFUR DIOXIDE
1984 MAX ANNUAL MEAN
EAST - WEST PROFILE
0.05
0.04
0.03
0.02
0.01
0.00
CONCENTRATION (PPM)

Figure 1-10. United States map of the highest annual arithmetic mean SO$_2$ concentration by SMSA, 1984.

Carbon Monoxide (CO) - Nationally, the second highest non-overlapping 8-hour average CO levels at 157 sites decreased 34 percent between 1975 and 1984 (Figure 1-11). Although the median rate of improvement has been approximately 5 percent per year, this rate is less pronounced in the last few years. The estimated number of exceedances of the 8-hour NAAQS decreased 88 percent between 1975 and 1984 (Figure 1-12). CO emissions decreased 14 percent during the same period (Figure 1-13). Because CO monitors are typically located to identify potential problems, they are likely to be placed in traffic saturated areas that may not experience significant increases in vehicle miles of travel. As a result, the air quality levels at these locations generally improve at a rate faster than the nationwide reduction in emissions. Between 1983 and 1984, CO levels decreased only 1 percent. This leveling off appears to be consistent with CO emissions for the highway vehicle portion of the transportation category which showed a 1 percent decrease between 1983 and 1984. The most recent 1984 highest second maximum nonoverlapping 8-hour average CO concentration is plotted for the 80 largest SMSA(s) (Figure 1-14). The east-west profile indicates that many of these urban areas in all geographic regions have air quality at or exceeding the 9 ppm level of the standard.

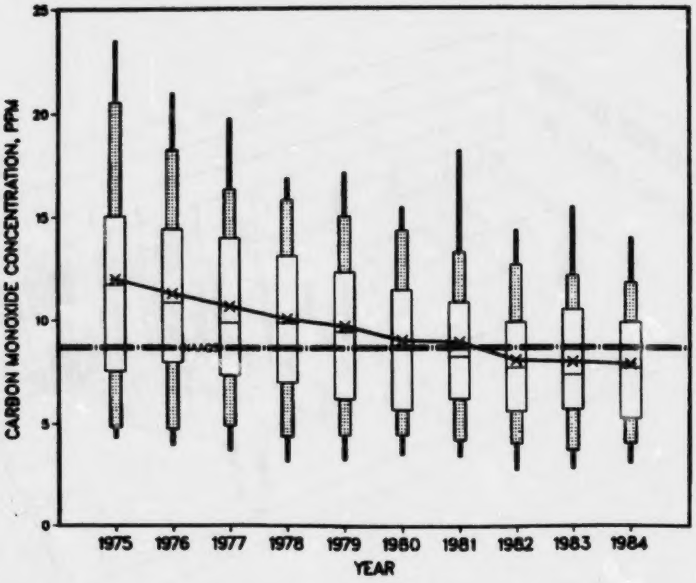


Figure 1-11. National boxplot trend in second highest nonoverlapping 8-hour average CO concentrations, 1975 - 1984.

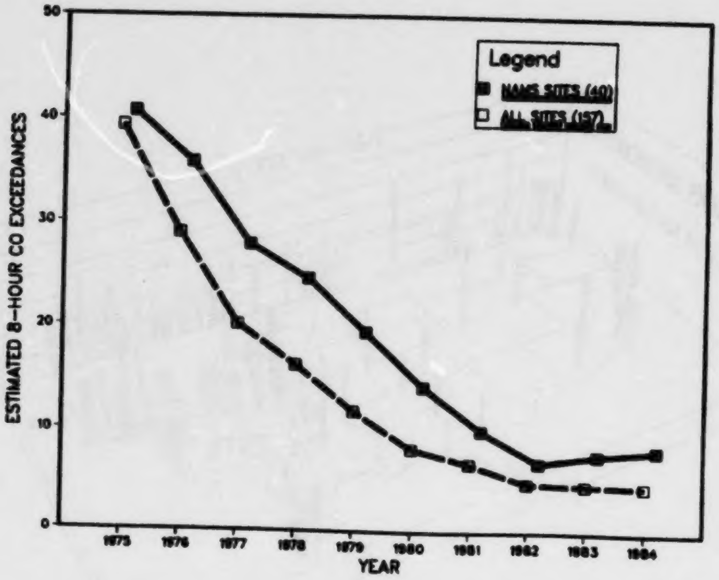


Figure 1-12. National trend in the composite average of the estimated number of exceedances of the 8-hour CO NAAQS, 1975 - 1984.

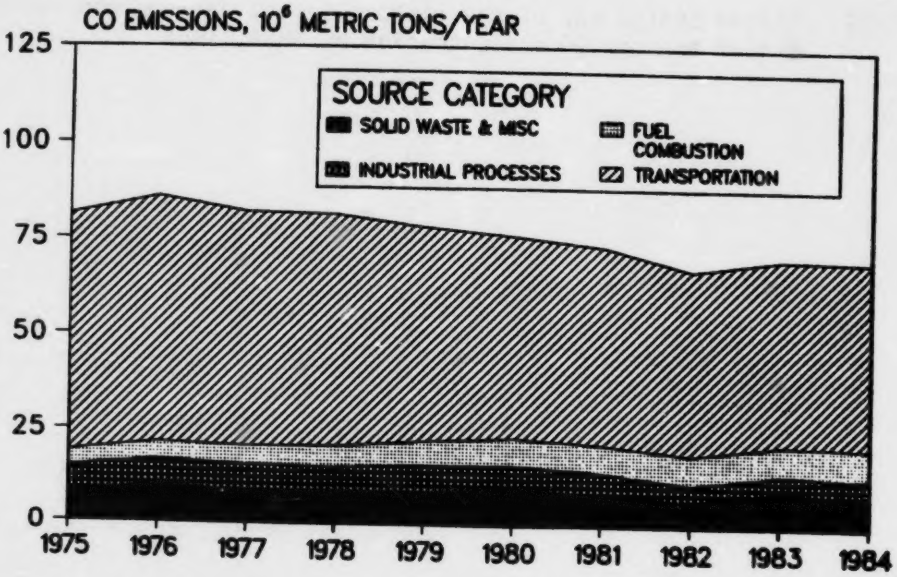


Figure 1-13. National trend in emissions of carbon monoxide, 1975 - 1984.

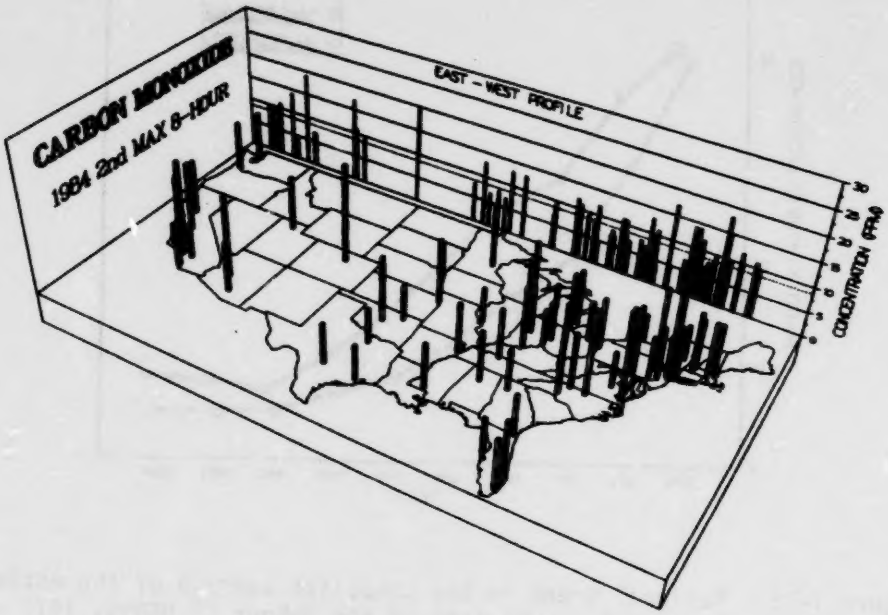

CARBON MONOXIDE
1984 2nd MAX 8-HOUR
EAST - WEST PROFILE
30
25
20
15
10
5
0
CONCENTRATION (PPM)

Figure 1-14. United States map of the highest second maximum nonoverlapping 8-hour average CO concentration by SMSA, 1984.

Nitrogen Dioxide (NO_2) - Annual average NO_2 levels, measured at 119 sites, increased from 1975 to 1979, decreased through 1983 and then recorded a slight increase in 1984 (Figure 1-15). The 1984 composite NO_2 average, however, is 10 percent lower than the 1975 level indicating a downward trend during the overall period. The trend in the estimated nationwide emissions of nitrogen oxides (NO_x) is similar to the NO_2 air quality trend. Between 1975 and 1984, total nitrogen oxide emissions increased by 3 percent, but highway vehicle emissions, the source category likely impacting the majority of NO_2 monitoring sites, decreased by 4 percent (Figure 1-16). Between 1983 and 1984, the NO_2 composite average increased by 2 percent, while the estimated emissions of nitrogen oxides increased by 3 percent. The most recent 1984 highest annual arithmetic mean NO_2 concentration is plotted for the 80 largest SMSA(s) (Figure 1-17). Los Angeles, California is the only area in the country exceeding the air quality standard of .053 ppm.

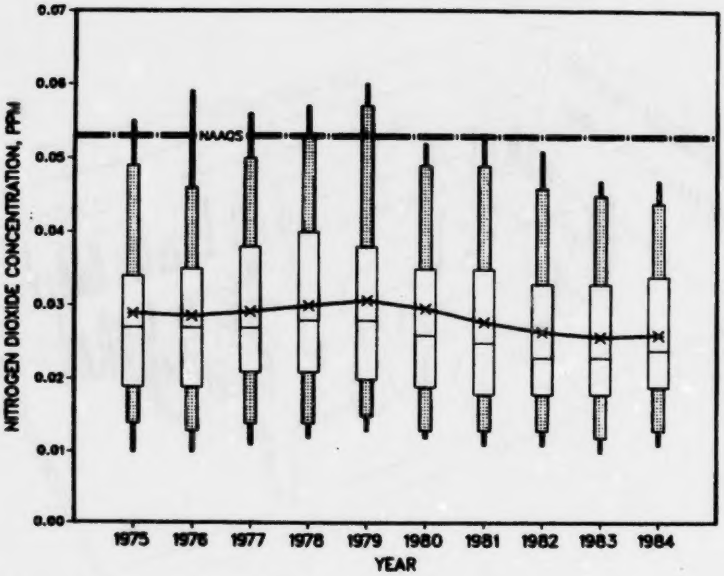


Figure 1-15. National boxplot trend in annual average NO_2 concentrations 1975 - 1984.

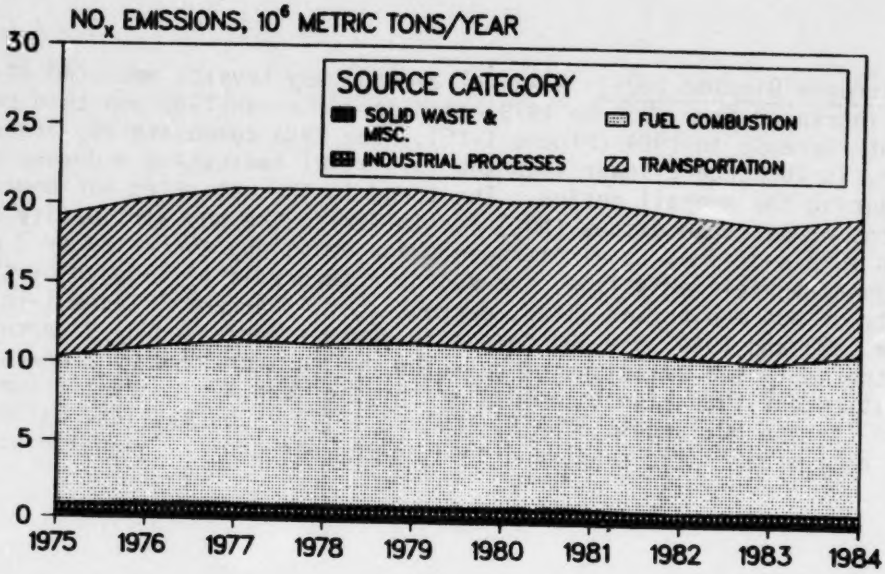


Figure 1-16. National trend in emissions of nitrogen oxides, 1975 - 1984.

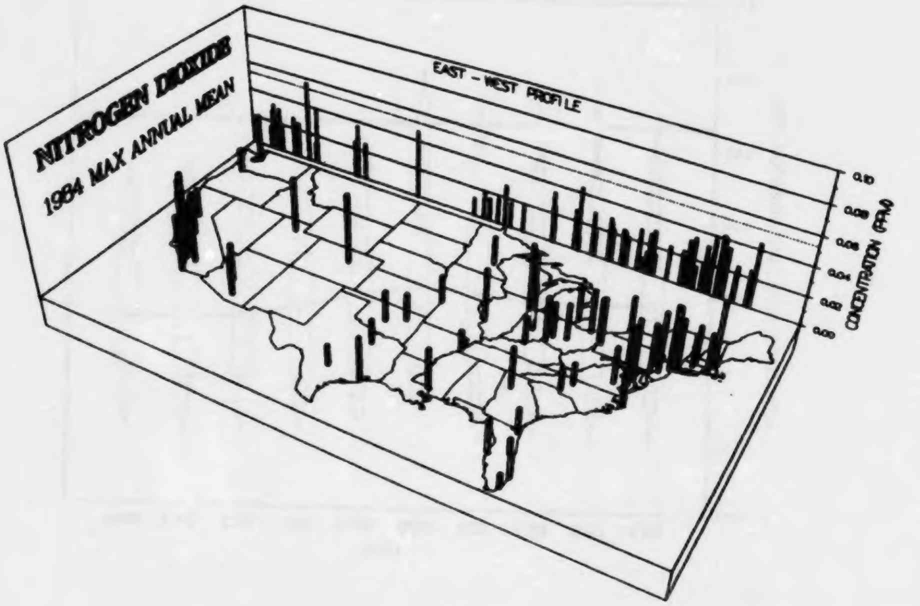

NITROGEN DIOXIDE
1984 MAX ANNUAL MEAN
EAST - WEST PROFILE
0.10
0.08
0.06
0.04
0.02
0.00
CONCENTRATION (PPM)

Figure 1-17. United States map of the highest annual arithmetic mean NO$_2$ concentration by SMSA, 1984.

Ozone (O_3) - Nationally, the composite average of the second highest daily maximum 1-hour O_3 values, recorded at 163 sites, decreased 17 percent between 1975 and 1984 (Figure 1-18). Volatile organic compound (VOC) emissions decreased 6 percent during the same period (Figure 1-19). Although the 1984 composite average for the 163 trend sites is 17 percent lower than the 1975 average, the interpretation of this decrease is complicated by a calibration change for O_3 measurements that occurred in the 1978-79 time period. The stippled portion of Figures 1-19 and 1-20 indicate data affected by measurements taken prior to the calibration change. In the post calibration period (1979 to 1984), O_3 levels decreased 7 percent (Figure 1-18), while VOC emissions decreased 10 percent. The estimated number of exceedances of the O_3 standard decreased 36 percent (Figure 1-20). The O_3 trends in the 1980's show that the 1980 and 1983 values were higher than those in 1981, 1982 and 1984. The previously reported increase between 1982 and 1983[11] was followed by a decrease of approximately 10 percent between 1983 and 1984. The magnitude of the 1982-83 increase and 1983-84 decrease was likely attributable to meteorological conditions that were more conducive to O_3 formation in 1983. The 1984 ambient ozone levels are very similar to the 1981-82 levels. This occurred despite an estimated national growth of almost 200 billion vehicle miles of travel between 1980 and 1984[15] and an expansion of economic activity in 1984. The most recent 1984 highest second daily maximum 1-hour average O_3 concentration is plotted for the 80 largest SMSAs (Figure 1-21). Slightly over half of these areas did not meet the 0.12 ppm standard in 1984. The highest concentrations are observed in Southern California, but high levels also persist in the Texas Gulf Coast, Northeast corridor, and other heavily populated regions.

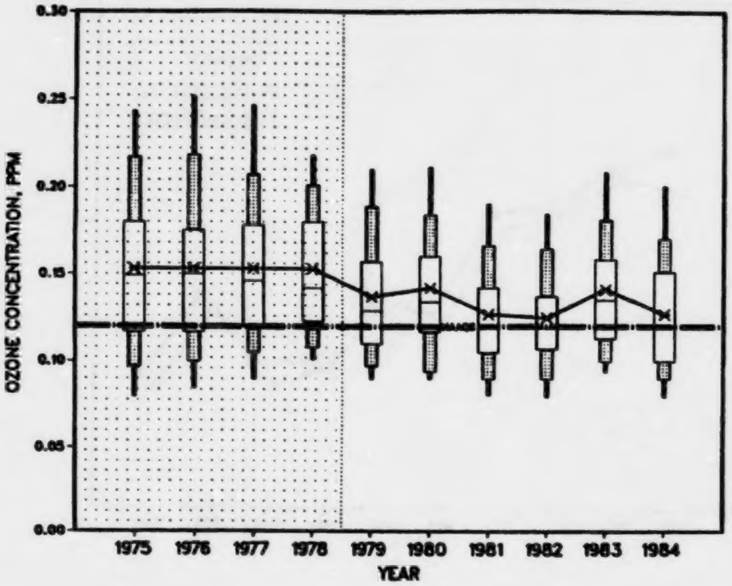


Figure 1-18. National boxplot trend in second highest daily maximum 1-hour O_3 concentrations, 1975 - 1984.

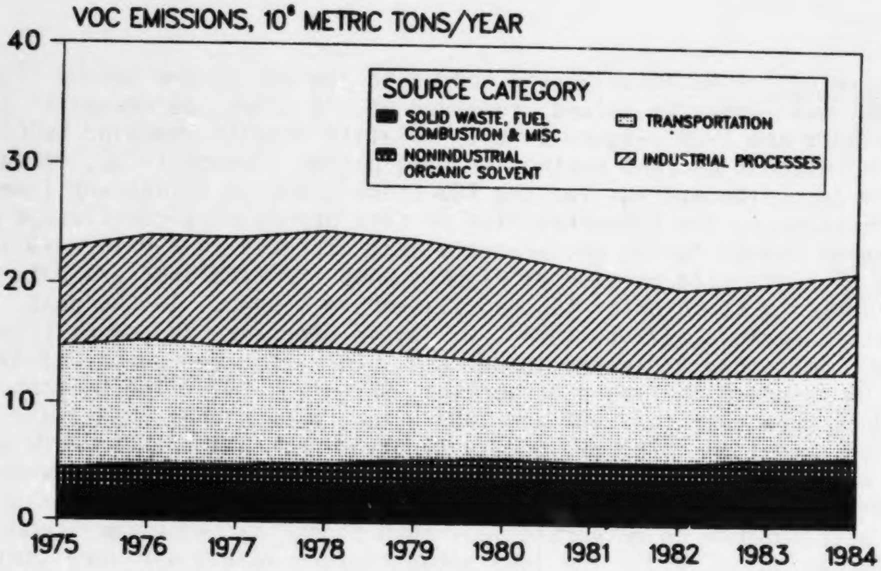


Figure 1-19. National trend in emissions of volatile organic compounds, 1975 - 1984.

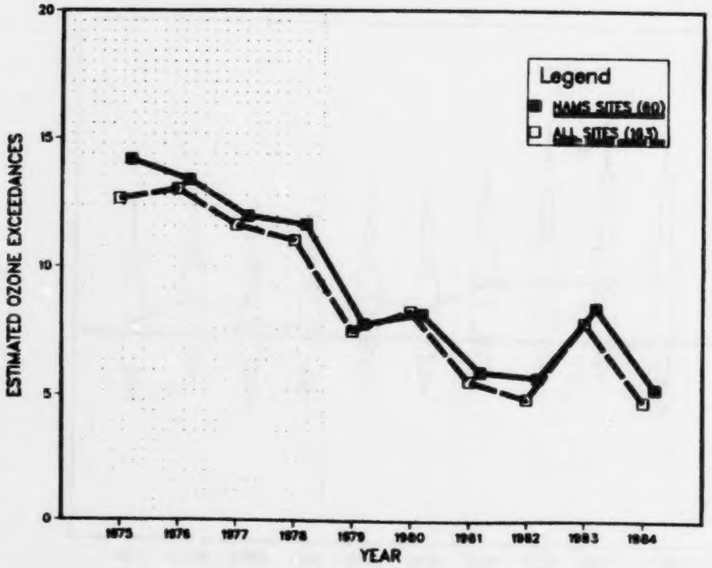


Figure 1-20. National trend in the composite average of the number of daily exceedances of the O_3 NAAQS in the O_3 season, 1975 - 1984.

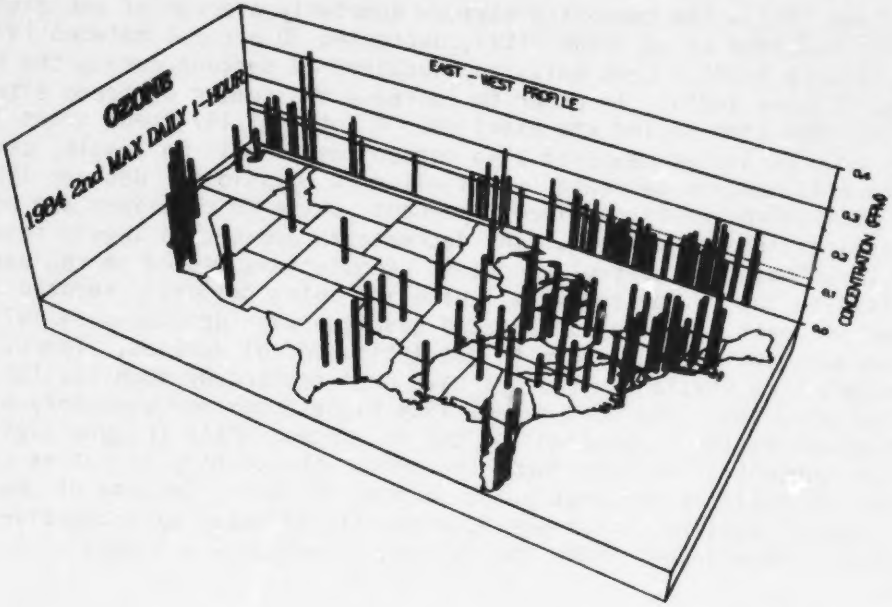

OZONE
1984 2nd MAX DAILY 1-HOUR
EAST - WEST PROFILE
CONCENTRATION (PPM)

Figure 1-21. United States map of the highest second daily maximum 1-hour average O_3 concentration by SMSA, 1984.

Lead (Pb) - The composite maximum quarterly average of ambient Pb levels, recorded at 36 urban sites, decreased 70 percent between 1975 and 1984 (Figure 1-22). Lead emissions declined 72 percent during the same period (Figure 1-23). In order to increase the number of trend sites, the 1980 to 1984 time period was examined. A total of 147 trend sites (1980 to 1984) from 23 States measured a 45 percent decline in Pb levels, corresponding to a 43 percent decrease in estimated Pb emissions. Between 1983 and 1984 ambient Pb levels declined 7 percent, while Pb emissions are estimated to have declined 13 percent. The decrease in ambient Pb levels results from three main EPA control programs. Regulations issued in the early 1970's resulted in the Pb content of all gasoline being gradually reduced over the period of years. Secondly, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices. Third, Pb emissions from stationary sources have been reduced by both the TSP and Pb control programs. The most recent 1984 highest maximum quarterly average lead concentration is plotted for the 80 largest SMSAs (Figure 1-24). The highest concentrations are found throughout the country in cities containing nonferrous smelters or other point sources of lead. Because of the switch to unleaded gasoline, other areas, primarily affected by automotive lead emissions, show levels below the current standard of 1.5 ug/m^3.

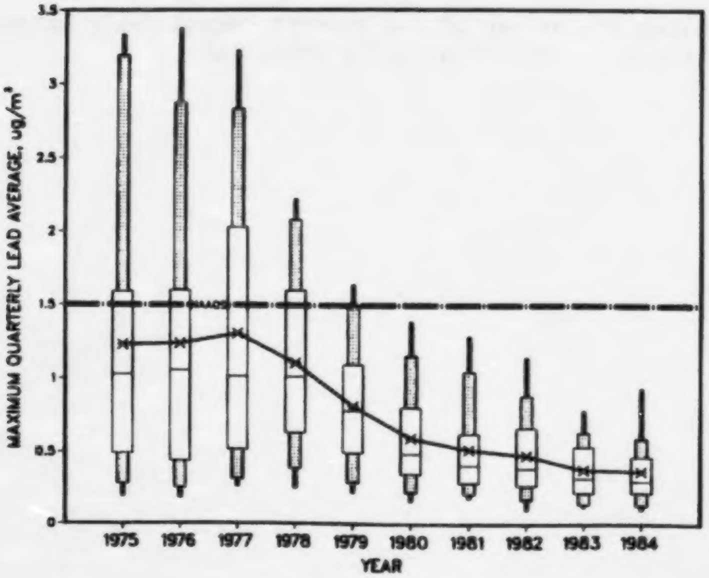


Figure 1-22. National boxplot trend in maximum quarterly average Pb concentrations, 1975 - 1984.

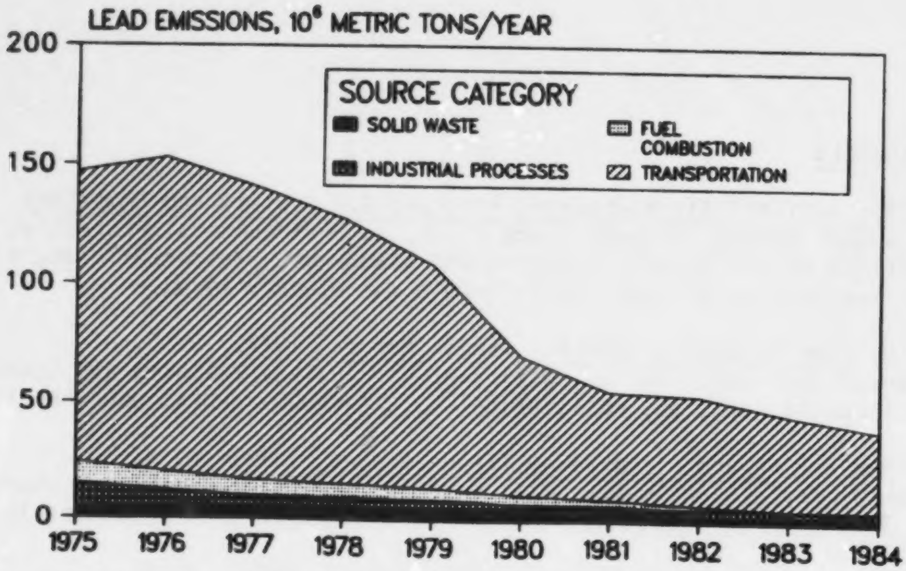


Figure 1-23. National trend in lead emissions, 1975 - 1984.

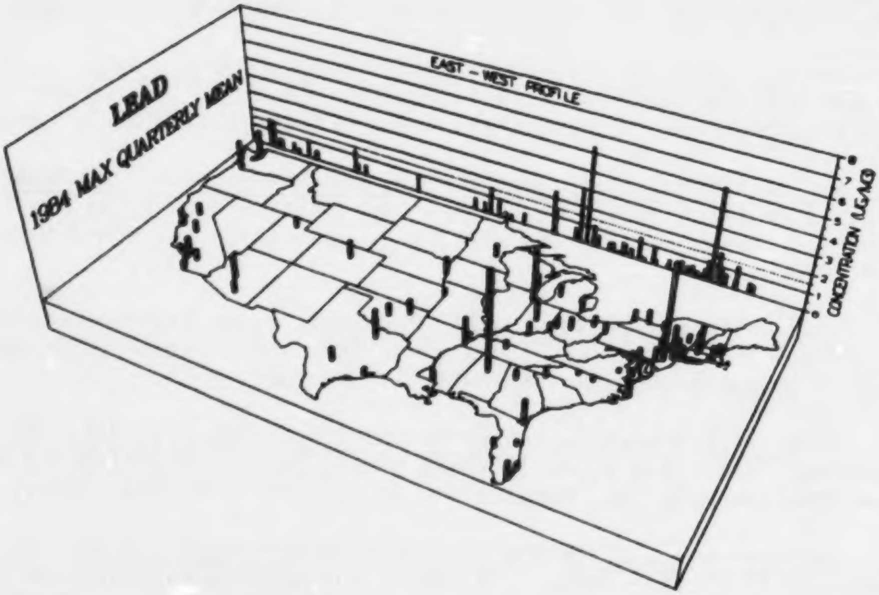

LEAD
1984 MAX QUARTERLY MEAN
EAST – WEST PROFILE
CONCENTRATION (UG/M3)
0
1
2
3
4
5
6
7
8

Figure 1-24. United States map of the highest maximum quarterly average lead concentration by SMSA, 1984.

1.3 REFERENCES

1. The National Air Monitoring Program: Air Quality and Emissions Trends - Annual Report, Volumes 1 and 2. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/1-73-001a and b. July 1973.

2. Monitoring and Air Quality Trends Report, 1972. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA-450/1-73-004. December 1973.

3. Monitoring and Air Quality Trends Report, 1973. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/1-74-007. October 1974.

4. Monitoring and Air Quality Trends Report, 1974. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA 450/1-76-001. February 1976.

5. National Air Quality and Emission Trends Report, 1975. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA 450/1-76-002. November 1976.

6. National Air Quality and Emission Trends Report, 1976. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/1-77-002. December 1977.

7. National Air Quality, Monitoring, and Emissions Trends Reports, 1977. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA-450/2-78-052. December 1978.

8. 1980 Ambient Assessment - Air Portion. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-81-014. February 1981.

9. National Air Quality and Emissions Trends Report, 1981. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-83-011. April 1983.

10. National Air Quality and Emissions Trends Report, 1982. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-84-002. March 1984.

11. National Air Quality and Emissions Trends Report, 1983. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/4-84-029. April 1985.

12. Federal Register, Vol. 43, June 22, 1978, pp 26971-26975.

13. Hauser, Thomas R., U. S. Environmental Protection Agency, memorandum to Richard G. Rhoads, January 11, 1984.

14. Frank, N. H., "Nationwide Trends in Total Suspended Particulate Matter and Associated Changes in the Meaurement Process," Proceedings of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. October 1984.

15. Highway Statistics 1984, U. S. Department of Transportation, Federal Highway Administration, Washington, D. C. Publication No. HHP-41/10-85(3M)QE. October 1985.

2. INTRODUCTION

This report focuses on both 10-year (1975-1984) and 5-year (1980-1984) national air quality trends in each of the major pollutants as well as Regional and, where appropriate, short-term air quality trends. The national analyses are complimented in Section 5 with air quality trends in selected urbanized areas for the period 1980 through 1984. In both the national 5-year trend and the urbanized area trends, the shorter time period was used to expand the number of sites available for trend analysis. The areas that were examined are: Atlanta, GA; Boston, MA; Chicago, IL-Northwestern IN; Denver, CO; Houston, TX; Los Angeles-Long Beach, CA; New York, NY-Northeastern NJ; Philadelphia, PA-NJ; Portland, OR-WA; and St. Louis, MO-IL.

The national air quality trends are presented for all sites and the National Air Monitoring Station (NAMS) sites. The NAMS were established through monitoring regulations promulgated in May 1979[1] to provide accurate and timely data to the U. S. Environmental Protection Agency (EPA) from a national air monitoring network. The NAMS are located in areas with high pollutant concentrations and high population exposure. These stations meet uniform criteria for siting, quality assurance, equivalent analytical methodology, sampling intervals, and instrument selection to assure consistent data reporting among the States. Other sites operated by the State and local air pollution control agencies, such as the State and Local Air Monitoring Stations (SLAMS) and Special Purpose Monitors (SPM), in general, also meet the same rigid criteria, except that in addition to being located in the area of highest concentration and high population exposure, they are located in other areas as well.

In addition to ambient air quality, trends are also presented for annual nationwide emissions. These emissions are estimated using the best available engineering calculations; the ambient levels presented are averages of direct measurements. The emission trends are taken from the EPA publication, National Air Pollutant Emission Estimates, 1940-1984[2] and the reader is referred to this publication for more detailed information.

Air quality progress is measured by comparing the ambient air pollution levels with the appropriate primary and secondary National Ambient Air Quality Standards (NAAQS) for each of the pollutants (Table 2-1). Primary standards protect the public health; secondary standards protect the public welfare as measured by effects of pollution on vegetation, materials, and visibility. The standards are further categorized for long or short term exposure. Long-term standards specify an annual or quarterly mean that may not be exceeded; short-term standards specify upper limit values for 1-, 3-, 8-, or 24-hour averages. With the exception of the pollutant ozone, the short-term standards are not to be exceeded more than once per year. The ozone standard requires that the expected number of days per calendar year with daily maximum hourly concentrations exceeding 0.12 parts per million (ppm) be less than or equal to one.

TABLE 2-1. National Ambient Air Quality Standards (NAAQS)

POLLUTANT	PRIMARY (HEALTH RELATED)		SECONDARY (WELFARE RELATED)	
	AVERAGING TIME	CONCENTRATION	AVERAGING TIME	CONCENTRATION
TSP	Annual Geometric Mean	75 ug/m^3	Annual Geometric Mean	60 ug/m^3*
	24-hour	260 ug/m^3	24-hour	150 ug/m^3
SO$_2$	Annual Arithmetic Mean	(0.03 ppm) 80 ug/m^3	3-hour	1300 ug/m^3 (0.50 ppm)
	24-hour	(0.14 ppm) 365 ug/m^3		
CO	8-hour	9 ppm (10 mg/m^3)	No Secondary Standard**	
	1-hour	(35 ppm) 40 mg/m^3	No Secondary Standard	
NO$_2$	Annual Arithmetic Mean	0.053 ppm (100 ug/m^3)	Same as Primary	
O$_3$	Maximum Daily 1-hour Average	0.12 ppm (235 ug/m^3)	Same as Primary	
Pb	Maximum Quarterly Average	1.5 ug/m^3	Same as Primary	

*This annual geometric mean is a guide to be used in assessing implementation plans to achieve the 24-hour standard of 150 ug/m^3.

**Because no standards appear to be requisite to protect the public welfare from any known or anticipated adverse effects from ambient CO exposures, EPA rescinded the existing secondary standards.

Section 4 of this report, "Air Quality Levels in Standard Metropolitan Statistical Areas (SMSA's);" provides interested members of the air pollution control community, the private sector and the general public with greatly simplified air pollution information. Air quality statistics are presented for each of the pollutants for all SMSA's with populations exceeding 500,000 for the years 1982, 1983 and 1984.

2.1 DATA BASE

The ambient air quality data used in this report were obtained from EPA's National Aerometric Data Bank (NADB). Air quality data are submitted to the NADB by both State and local governments, as well as federal agencies. At the present time, there are over 250 million air pollution measurements on the NADB, the vast majority of which represent the more heavily populated urban areas of the Nation.

As in last year's report[3], the size of the available air quality trends data base has been expanded by merging data at sites which have experienced changes in the agency operating the site, the instrument used, or a change in the project code, such as a change from residential to commercial. A discussion of the impact of the merging of the air quality data is presented in each of the individual pollutant discussions.

In order for a monitoring site to have been included in the national 10-year trend analysis, the site had to contain at least 8 out of the 10 years of data in the period 1975 to 1984. For the national 5-year trend and urban area analyses, the site had to contain 4 out of 5 years of data to be included as a trend site. Each year with data had to satisfy an annual data completeness criterion. To begin with, the air quality data are divided into two major groupings -- 24-hour measurements and continuous 1-hour measurements. The 24-hour measurements are obtained from monitoring instruments that produce one measurement per 24-hour period and are operated on a systematic sampling schedule of once every 6 days or 61 samples per year. Such instruments are used to measure TSP, SO_2, NO_2, and Pb. For these measurement methods, the NADB defines a valid quarter's record as one consisting of at least five sample measurements representively distributed among the months of that quarter. Distributions of measurements that show no samples in 2 months of a quarter or that show no samples in 1 month and only one sample in another month are judged unacceptable for calculating a representative estimate of the mean. A valid annual mean for TSP, SO_2 and NO_2, measured with this type of sampler, requires four valid quarters to satisfy the NADB criteria. For the pollutant lead, the data used has to satisfy the criteria for a valid quarter in at least 3 of the 4 possible quarters in a year for the national trend.

The 1-hour data are obtained from monitoring instruments that operate continuously, producing a measurement every hour for a possible total of 8760 hourly measurements in a year. For continuous hourly data, a valid annual mean for SO_2 and NO_2 requires at least 4380 hourly observations. This same annual data completeness criteria of at least 4380 hourly values was required for the CO standard related statistics - the second maximum nonoverlapping 8-hour average and the estimated number of exceedances of the 8-hour average CO standard.

A slightly different criteria was used for the SO_2 standard related daily statistics - the second daily maximum 24-hour average and the estimated number of daily exceedances of the SO_2 standard. Instead of requiring 4380 or more hourly values, 182 or more daily values were required. A valid day is defined as one consisting of at least 18 hourly observations. This minor modification in the criteria resulted in a 2 percent difference in the total number of SO_2 trend sites for the 10 year trend evaluation of the annual arithmetic mean, 229 sites, as opposed to 224 trend sites for the evaluation of both the second maximium daily average and the estimated number of standard exceedances. There was no difference in the number of SO_2 trend sites for the 5 year trend period. Each statistic - annual arithmetic mean, the second maximum daily average and the estimated number of exceedances - had the same number of trend sites.

Finally, because of the seasonal nature of ozone, both the second daily maximum 1-hour value and the estimated number of exceedances of the O_3 NAAQS were calculated for the ozone season, which varies by State.[4] For example, in California the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October. In order for a site to be included it had to have at least 50 percent of the daily data in the ozone season.

For all the pollutants, the site must satisfy the annual completeness criterion, specified above, in at least 8 out of 10 years to be included in the 10-year air quality trends data base and 4 out of 5 years in both the 5-year trend and urbanized area trend data bases. The shorter time period was used in the urbanized area analyses to expand the number of sites available for trend analyses.

In calculating the national and urban area trend analyses each site was weighted equally. The report examines both 10-year (1975 to 1984) and 5-year (1980 to 1984) trends. The 5-year trend period is being introduced at this time to increase the number of trend sites available for analysis (Table 2-2). The trend from 1980 on reflects the period following the promulgation of the monitoring regulations.[1] The regulations required uniform siting of monitors and placed greater emphasis on quality assurance. In general, the data from the post 1980 period should be of the highest quality. As would be expected, there are considerably more trend sites for the 5-year period than the 10-year period - 3697 total trend sites versus 2048 trends sites, respectively (Table 2-2). This 81 percent increase in the number of trends sites for the 5-year period over the 10-year period reflects the greater utilization of the ambient air quality data that is achieved by examining the shorter time period. Trend sites can be found in all EPA Regions (Figure 2-1) for TSP, SO_2, CO, NO_2 and O_3 and nine EPA Regions for lead for the 5-year period.

2.2 TREND STATISTICS

The air quality analyses presented in this report comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators.[6] This task force was established in January 1980 to recommend standardized air quality indicators and statistical methodologies for presenting air quality status and trends. The Task Force report was published in February 1981. The air quality statistics used in these pollutant-specific trend analyses relate directly to the appropriate NAAQS's. Two types of standard-related statistics are used - peak statistics

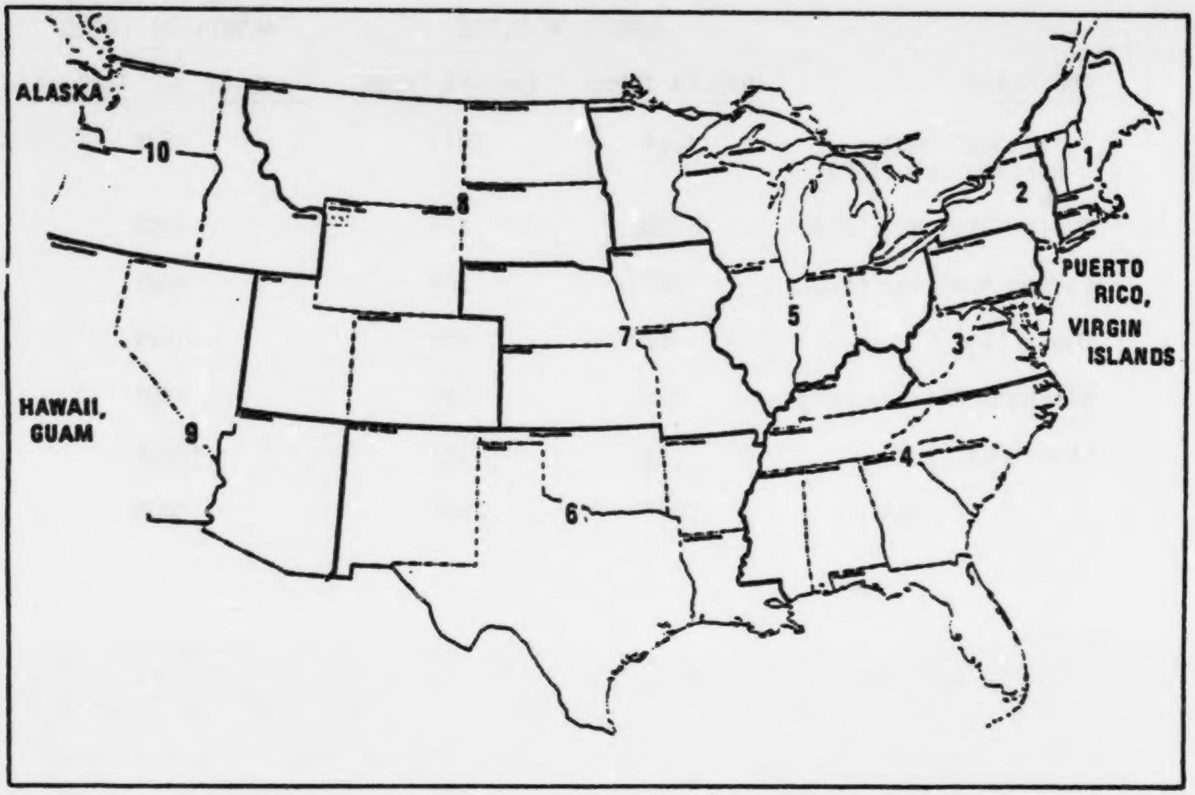

ALASKA
10
8
7
5
1
2
PUERTO RICO,
VIRGIN ISLANDS
3
HAWAII,
GUAM
9
6
4

Figure 2-1. Ten regions of the U. S. Environmental Protection Agency.

(the second maximum 24-hour SO_2 average, the second maximum nonoverlapping 8-hour CO average, and the second daily maximum 1-hour O_3 average) and long-term averages (the annual geometric mean for TSP, the annual

TABLE 2-2. Comparison of Number of Sites for 10-Year and 5-Year Air Quality Trends

POLLUTANT	NUMBER OF SITES 1975-84 TREND	NUMBER OF SITES 1980-84 TREND	% CHANGE IN THE NUMBER OF TREND SITES 1975-84 vs. 1980-84
Total Suspended Particulate (TSP)	1344	2048	+52%
Sulfur Dioxide (SO_2)	229	477	+108%
Carbon Monoxide (CO)	157	309	+96%
Ozone ()$_3$)	163	480	+194%
Nitrogen Dioxide (NO_2)	119	236	+98%
Lead (Pb)	36	147	+308%
Total	2048	3697	+81%

arithmetic means for SO_2 and NO_2, and the quarterly arithmetic mean for lead). In the case of the peak statistics, the second maximum value is used, because this is the value which traditionally has been used to determine whether or not a site has or has not violated an air quality standard in a particular year, and, therefore, the second maximum value is of significant importance. A composite average of each of these statistics is used, by averaging each statistic over all available trend sites, in the graphical presentations which follow.

In addition to the standard related statistics, other statistics are used, when appropriate, to further clarify observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQS's. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling.

The emission data are reported as teragrams (one million metric tons) emitted to the atmosphere per year.[2] These are estimates of the amount and kinds of pollution being generated by automobiles, factories, and other sources, based upon the best available engineering calculations for a given time period. More detailed information on the calculation of emissions data is presented in Reference 2.

2.3 REFERENCES

1. Federal Register, Vol. 44, May 10, 1979, pp 27558-27604

2. National Air Pollutant Emission Estimates, 1940-1984. U.S. Environmental Protection Agency. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 450/4-85-014. January 1986.

3. National Air Quality and Emission Trends Report, 1983. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA-450/4-84-029. April 1985.

4. Rhoads, Richard G., U. S. Environmental Protection Agency, memorandum to the Director of the Environmental Services Divisions and Air and Waste Management Divisions, EPA Regions I through X, December 15, 1982.

5. Dixon, W. J. and F. J. Massey (1957). Introduction to Statistical Analysis, McGraw-Hill, NY. 1957.

6. U.S. Environmental Protection Agency Intra-Agency Task Force Report on Air Quality Indicators. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA-450/81-015. February 1981.

3. NATIONAL AND REGIONAL TRENDS IN CRITERIA POLLUTANTS

This chapter focuses on both 10-year (1975-1984) and more recent 5-year (1980-1984) trends in each of the six major pollutants, as well as short term air quality trends. Comparisons are made between all the trend sites and the subset of NAMS. Trends are examined for both the Nation and the ten EPA Regions.

The air quality trends data base has been expanded for all pollutants by merging data at sites which have experienced changes in the agency operating the site, the instrument used, or the designation of the project code, such as residential to commercial. The impact of merging the air quality data is discussed in each of the individual pollutant sections.

The air quality trends information is presented using trend lines, confidence intervals, boxplots[1] and bar graphs. This report presents statistical confidence intervals to facilitate a better understanding of measured changes in air quality. Confidence intervals are placed around composite averages, which are based on sites that satisfy annual data completeness requirements. The confidence intervals can be used to make comparisons between years; if the confidence intervals for any 2 years do not overlap, then the composite averages of the 2 years are significantly different (Figure 3-1). Ninety-five percent confidence intervals for composite averages of annual means (arithmetic and geometric) and second maxima were calculated from a two-way analysis of variance followed by an application of the Tukey Studentized Range.[2] The confidence intervals for composite averages of estimated exceedances were calculated by fitting Poisson distributions[3] to the exceedances each year and then applying the Bonferroni multiple comparisons procedure.[4] The utilization of these procedures is explained in publications by Pollack, Hunt and Curran[5] and Pollack and Hunt.[6]

The boxplots have the advantage of displaying, simultaneously, several features of the data. Figure 3-2 illustrates the use of this technique in presenting the 5th, 10th, 25th, 50th (median), 75th, 90th and 95th percentiles of the data, as well as the composite average. The 5th, 10th and 25th percentiles depict the "cleaner" sites. The 75th, 90th and 95th depict the "dirtier" sites, and the median and average describe the "typical" sites. For example, 90 percent of the sites would have concentrations lower than the 90th percentile. Although the average and median both characterize typical behavior, the median has the advantage of not being affected by a few extremely high observations. The use of the boxplots allow us to simultaneously compare trends in the "cleaner", "typical" and "dirtier" sites.

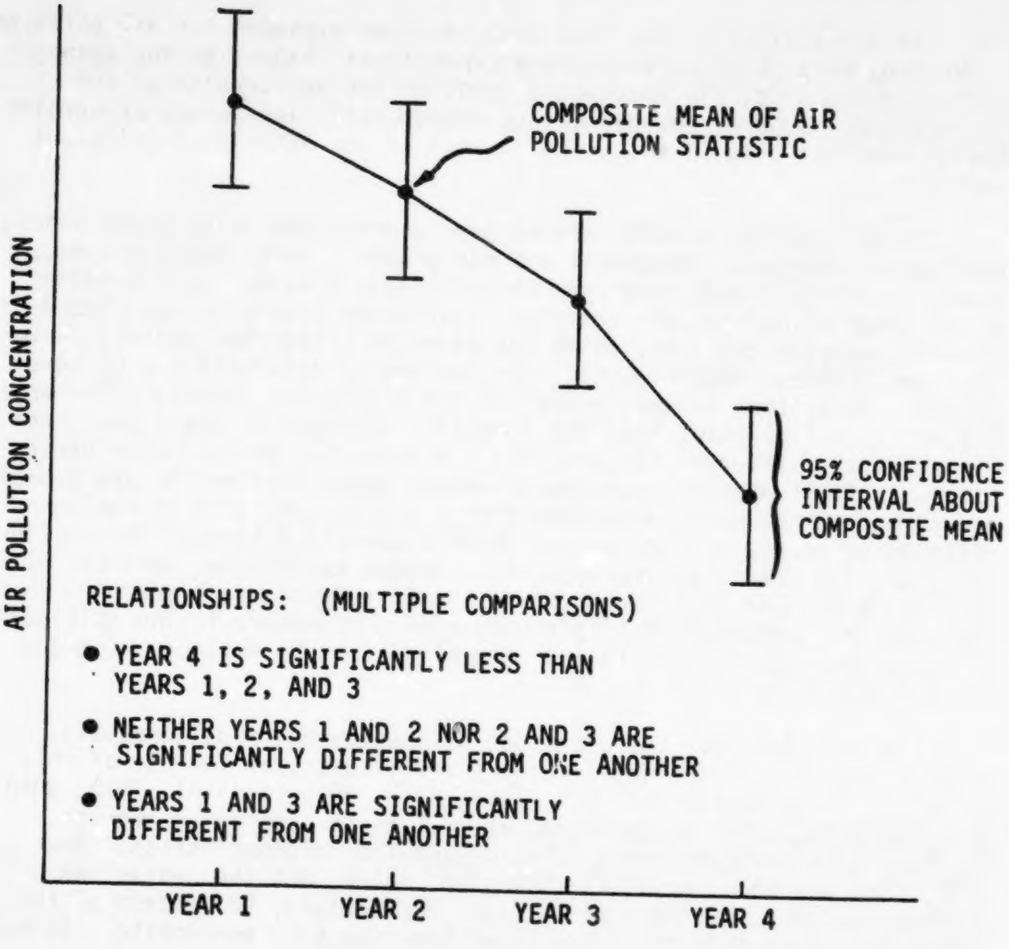


Figure 3-1. Sample illustration of use of confidence intervals to determine statistically significant change.

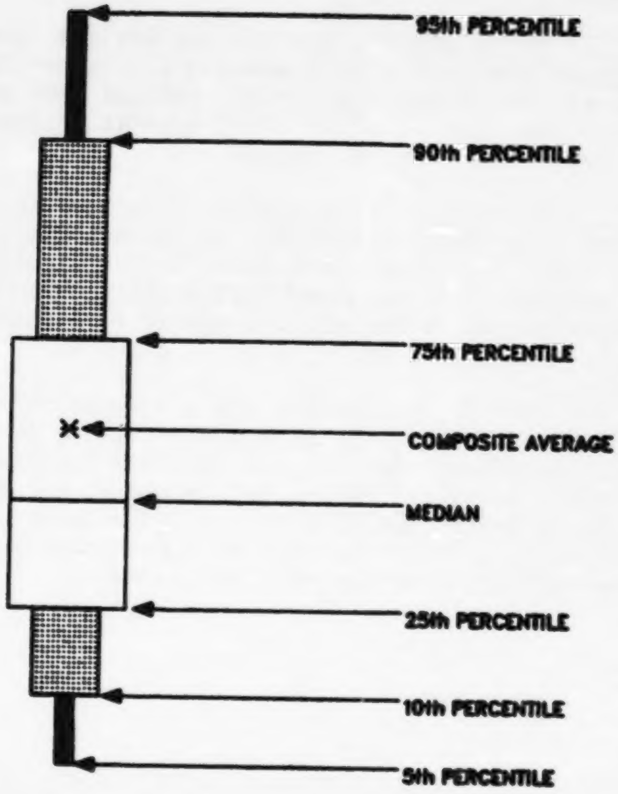

95th PERCENTILE
90th PERCENTILE
75th PERCENTILE
COMPOSITE AVERAGE
MEDIAN
25th PERCENTILE
10th PERCENTILE
5th PERCENTILE

Figure 3-2. Illustration of plotting conventions for box plots.

Boxplots of all trend sites are presented for each year in the 10-year trend. In the recent 5-year trend, the boxplots are presented for the years 1980 through 1984. Superimposed upon this presentation is the trend line from the 10-year period. The recent 5-year trend is being introduced at this time to increase the number of sites available for analysis. Future trends reports will focus on the post-1980 period to take advantage of the larger number of sites and the fact that the data from the post-1980 period should be of the highest quality, with sites meeting uniform siting criteria and high standards of quality assurance.

Bar graphs are used for the Regional comparisons with the 5-year trend data base. The composite average of the appropriate air quality statistic of the years 1982, 1983 and 1984 are presented. The approach is simple and it allows the reader at a glance to compare the short-term trend in all ten EPA Regions.

In addition to the standard related statistics, other statistics are used, when appropriate, to further clarify observed air quality trends. Particular attention is given to the estimated number of exceedances of the short-term NAAQS's. The estimated number of exceedances is the measured number of exceedances adjusted to account for incomplete sampling.

Finally, trends are also presented for annual nationwide emissions. These emissions data are estimated using the best available engineering calculations. The emission data are reported as teragrams (one million metric tons) emitted to the atmosphere per year.[7] These are estimates of the amount and kinds of pollution being generated by automobiles, factories, and other sources, based upon the best available engineering calculations for a given time period.

3.1 TRENDS IN TOTAL SUSPENDED PARTICULATE

Total Suspended Particulate (TSP) is a measure of suspended particles in the ambient air. These particles originate from a variety of stationary and mobile sources. TSP is measured using a high volume sampler which simply measures the total ambient particle concentration from suspended particles ranging up to approximately 45 microns in diameter. It does not provide additional information regarding particle size. There are both annual geometric mean and 24-hour National Ambient Air Quality Standards for TSP. The annual geometric mean standard is 75 micrograms per cubic meter (ug/m^3) not to be exceeded, while the 24-hour standard is 260 ug/m^3 not to be exceeded more than once per year. Because the annual mean is a more stable estimator of air quality, given the EPA recommended sampling frequency of once every 6 days, only the annual mean is used as a trend statistic.

3.1.1 Long-Term TSP Trends: 1975-84

The 10-year trend in average TSP levels, 1975 to 1984, is shown in Figure 3-3 for over 1300 sites geographically distributed throughout the Nation and for the subset of 325 National Air Monitoring Stations (NAMS) which are located in the large urban areas. The TSP levels are expressed in terms of the composite average annual geometric mean.

The curves shown in Figure 3-3 indicate a very slight decrease in composite levels from 1975-1981, followed by a sizeable decrease between 1981 and 1982 and stable levels between 1982 and 1984. The NAMS sites show higher composite levels than the sites for the Nation in general, but appear to show a similar pattern. The composite average of TSP levels measured at 1344 sites, distributed throughout the Nation, decreased 20 percent during the 1975 to 1984 time period and the NAMS decreased 22 percent. From the curves in Figure 3-3, it appears that most of this decrease occurred between the measured levels of 1981 and 1982. EPA has found, however, that the TSP data collected during the years 1979-1981 may be biased high due to the glass fiber filter used during these years, and that most of the large apparent 2-year decrease in pollutant concentrations between 1981 and 1982 can be attributed to a change in these filters.[8,9,10] For this reason, the portion of the Figure 3-3 graph corresponding to 1979-1981 is stippled, indicating the uncertainty associated with these data. Due to the change in TSP filters, the pattern of the yearly change in TSP between 1978 and 1982 is difficult to assess. On the basis of comparable filters used in 1978 and 1984, however, the long-term (7-year) improvement in TSP is estimated to be 19 percent. This is based on 1251 sites which measured TSP in both years.

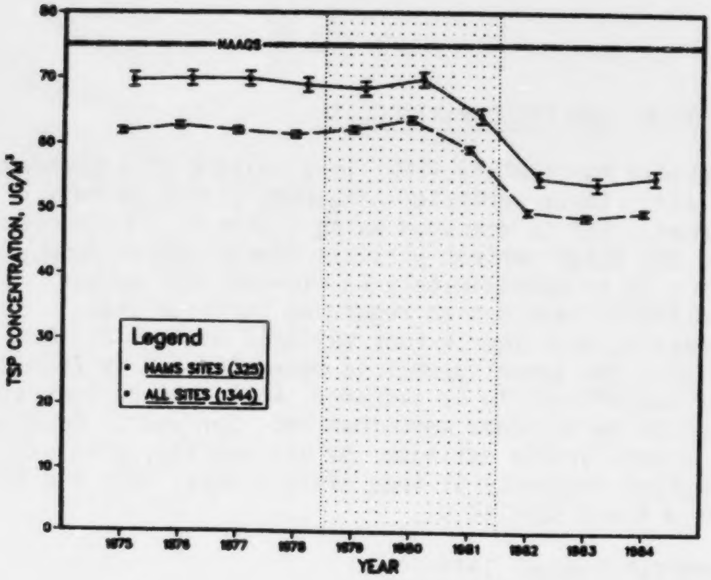


Figure 3-3. National trend in the composite average of the geometric mean total suspended particulate at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

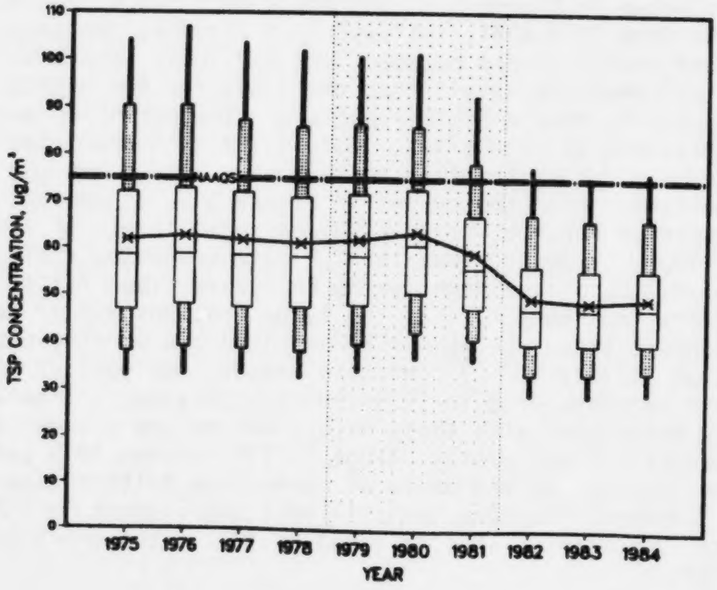


Figure 3-4. Boxplot comparisons of trends in annual geometric mean total suspended particulate concentrations at 1344 sites, 1975-1984.

Figures 3-3 and 3-4 present two different displays of the air quality trend at the 1344 TSP sites, nationally, over the 1975-1984 time period. Both permit evaluation of the 1978 and 1984 TSP levels in the context of the 10 year period, which is used for all pollutants. With 95 percent confidence intervals developed for the composite annual estimates (Figure 3-3), it can be seen that the 1984 as well as the 1982 and 1983 levels are all significantly lower than those of 1978. The data do not show statistically significant variation among these last 3 years. In Figure 3-4, boxplots present the entire national concentration distribution by year and show that a decrease occurred in every percentile level between 1978 and 1984.

Nationwide TSP emission trends show an overall decrease of 33 percent from 1975 to 1984. (See Table 3-1 and Figure 3-5). Since 1978, however, the particulate matter emissions have decreased 24 percent which is comparable to the decrease in ambient TSP levels. The reduction in particulate emissions occurred primarily because of the reductions in industrial processes. This is attributed to a combination of installation of control equipment and reduced industrial activity. Other areas of TSP emission reductions include reduced coal burning by non-utility users and installation of control equipment by electric utilities that burn coal.[7]

The trend in particulate emissions would not be expected to agree with the trend in ambient TSP levels due to the unaccounted for natural TSP background and uninventoried emissions sources such as reentrained dust. The apparent agreement between the ambient air quality and emissions data may be due in part to the favorable role of meteorology in recent years. An analysis of meteorological conditions for this period indicates a potential for lower TSP concentrations due to abnormally high precipitation, particularly in 1982 and 1983. Rainfall has the effect of minimizing fugitive dust entrainment and washing particles out of the air.

Figure 3-6 compares the trend in TSP with the annual percent deviation from normal precipitation. Qualitatively, the change in annual precipitation [11] tends to generally agree with the annual change in TSP concentrations. For example, the increase in TSP due to drought conditions in 1976 has been previously reported.[12] The decrease in TSP in 1982 has also been attributed, in part, to increased precipitation.[13] The relationship between TSP and rainfall also appears to correspond to the year to year variability in TSP during 1982-1984. TSP decreased between 1982 and 1983, while rainfall increased. Then in 1984, the TSP increased following a return of rainfall to more normal levels. The effect of rainfall on TSP concentrations was particularly important in California which experienced a State-wide increase in TSP levels in 1984. This change in TSP was examined in Southern California and was attributed to unusually low TSP concentrations in 1983 (particularly March and April) due to unusually rainy and unstable meteorological conditions.[14]

Table 3-1. National Particulate Emission Estimates, 1975-1984.

(million metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Transportation	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.3
Fuel Combustion	2.7	2.5	2.5	2.6	2.5	2.4	2.4	2.2	1.9	2.0
Industrial Processes	5.0	4.4	4.0	4.0	3.8	3.2	2.8	2.4	2.2	2.5
Solid Waste	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Miscellaneous	0.7	1.0	0.8	0.8	0.9	1.1	0.9	0.7	1.1	0.9
Total	10.4	9.7	9.1	9.2	9.0	8.5	7.9	7.0	6.7	7.0

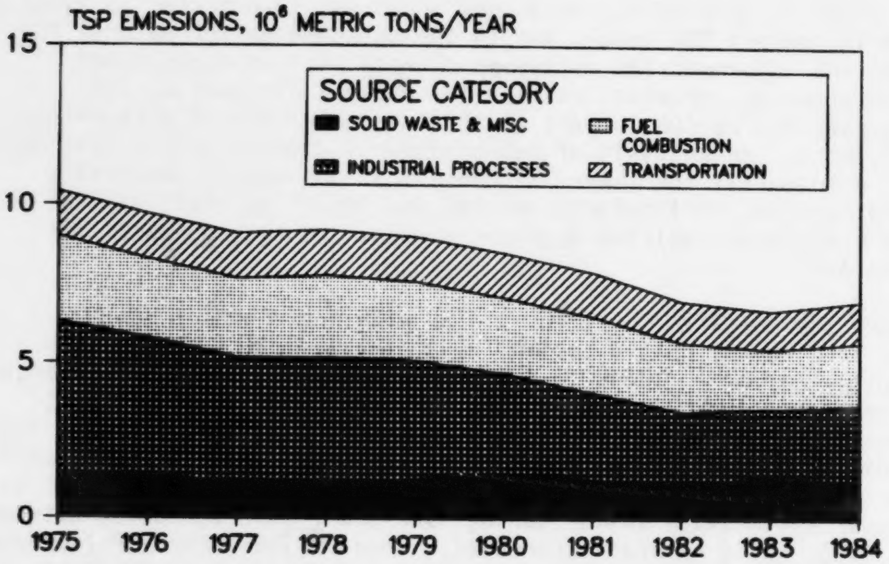
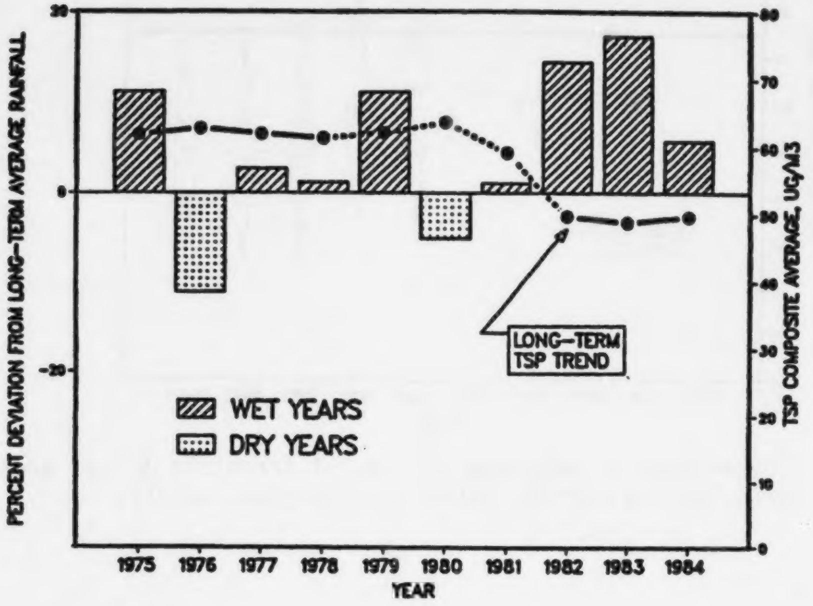


Figure 3-5. National trend in particulate emissions, 1975-1984.

Figure 3-6. Annual nationwide area - weighted total precipitation compared to long-term TSP trends, 1975-84.



3.1.2 Recent TSP Trends: 1980-84

The change in monitoring filters discussed in Section 3.1.1 complicates the evaluation of recent 5-year trends. Since future trends reports will be focusing on trends in the 1980's, however, Figure 3-7 presents a boxplot display of 1980-1984 TSP data base which represents over 2000 monitoring sites. These boxplots are superimposed on the longer 10 year trend line showing the remarkable similarity in composite average levels and insensitivity of the TSP data base to a 50 percent increase in monitoring sites. This lays the groundwork for a transition to this data base for future trends reports.

A more practical analysis of recent trends in TSP focuses on the regional variability among the last 3 years, 1982-1984. Figure 3-8 shows that within each Region all 3 years had similar TSP levels with 1983 predominantly displaying a 3 year minimum. This is consistent with the trend in the national composite levels and emission trends (Figure 3-5 and 3-7). The largest 2 year changes in ambient TSP levels consisted of a 7 percent decrease between 1982 and 1983 in Region VI and a 9 percent and 11 percent increase between 1983 and 1984 in Regions VIII and IX, respectively. The Region VI decrease is attributed to a delay in utilization of the new EPA monitoring filters at some sites in Texas while the increases in the Western Regions is due to changes in precipitation discussed previously.

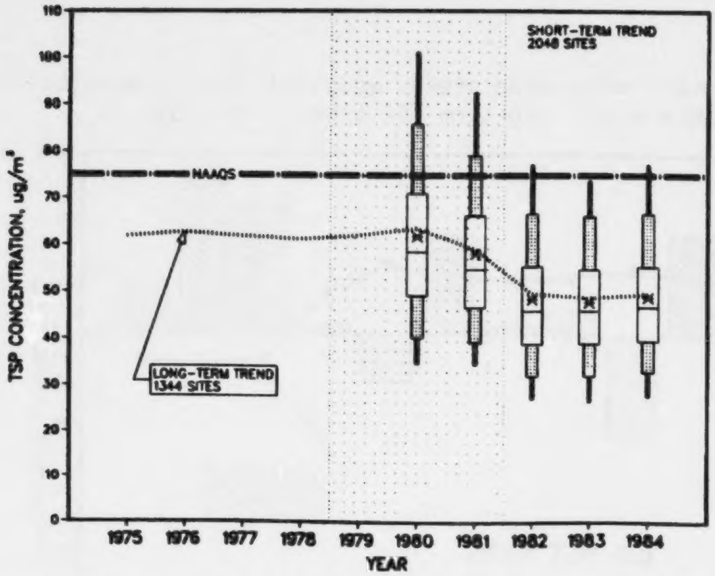


Figure 3-7. Comparison of long-term and recent trends in annual geometric mean total suspended particulate concentrations.

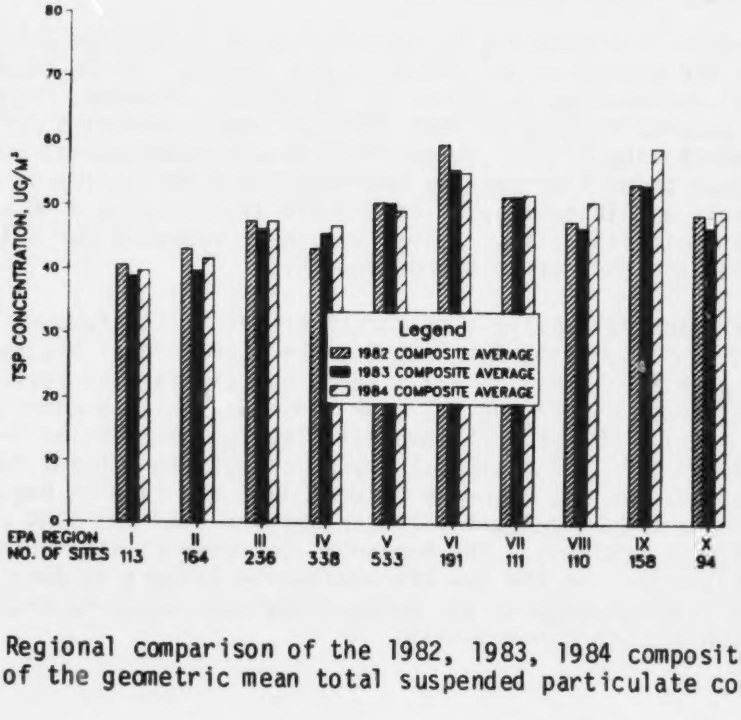


Figure 3-8. Regional comparison of the 1982, 1983, 1984 composite average of the geometric mean total suspended particulate concentration.

3.2 TRENDS IN SULFUR DIOXIDE

Ambient sulfur dioxide (SO_2) results primarily from stationary source coal and oil combustion and from nonferrous smelters. There are three NAAQS for SO_2: an annual arthmetic mean of 0.03 ppm, a 24-hour level of 0.14 ppm and a 3-hour level of 0.50 ppm. The first two standards are primary (health-related) standards, while the 3-hour NAAQS is a secondary (welfare-related) standard. The annual standard is not to be exceeded, while the short-term standards are not to be exceeded more than once per year. The trend analyses which follow are presented for the primary standards.

The trends in ambient concentrations are derived from continuous monitoring instruments which can measure as many as 8760 hourly values per year. The SO_2 measurements reported in this section are summarized into a variety of summary statistics which relate to the SO_2 NAAQS. The statistics on which ambient trends will be reported are the annual arithmetic mean concentration, the second highest annual 24-hour average (measured midnight to midnight), and the expected annual number of 24-hour exceedances of the 24-hour standard of 0.14 ppm.

3.2.1 Long-term SO_2 Trends: 1975-84

The long-term trend in ambient SO_2, 1975 to 1984, is graphically presented in Figures 3-9 to 3-11. In each figure, the trend at the NAMS is contrasted with the trend at all sites. For each of the statistics presented, a steady downward trend is evident through 1982, with some leveling off over the last 3 years. Nationally, the annual mean SO_2, examined at 229 sites, decreased at a median rate of approximately 5 percent per year; this resulted in an overall change of about 36 percent (Figure 3-9). The subset of 81 NAMS recorded higher average concentrations but declined at a higher rate of 7 percent per year.

The annual second highest 24-hour values displayed a similar decline between 1975 and 1984. Nationally, among 224 stations with adequate trend data, the median rate of change was 5 percent per year with an overall decline of 41 percent (Figure 3-10). The 78 NAMS exhibited a similar rate of improvement for an overall change of 35 percent. The estimated number of exceedances also showed declines for the NAMS as well as the composite of all sites (Figure 3-11). The vast majority of SO_2 sites, however, do not show any exceedances of the 24-hour NAAQS. Most of the exceedances as well as the bulk of the improvements occurred at source oriented sites including a few smelter sites in particular. The national composite estimated number of exceedances decreased 93 percent from 1975 to 1984. The apparent increase in exceedances for the NAMS during the beginning of the trend period is largely due to a NAMS site in Salt Lake City, Utah which is influenced by a nearby smelter. There is considerable variability in the number of exceedances at this site with the number of exceedances in 1976 being considerably greater than other years. This single site has caused the trend at the NAMS sites to peak in 1976.

The statistical significance of these long-term trends is graphically illustrated on Figures 3-9 to 3-11 with the 95 percent confidence intervals included on these figures. For both annual averages and peak 24-hour values, the SO_2 levels in 1984 are statistically different than levels observed during the 1970's. For expected exceedances of the 24-hour standard with its more rapid decline and higher variability, current levels are only statistically different than average exceedances in earlier years (1975-1978).

The inter-site variability for annual mean and annual second highest 24-hour SO_2 concentrations is graphically displayed in Figures 3-12 and 3-13. These figures show that higher concentrations decreased more rapidly and the concentration range among sites has also diminished.

Nationally, sulfur oxide emissions decreased 16 percent from 1975 to 1984 (Figure 3-14 and Table 3-2). These emissions increased from 1975 to 1976 due to improved economic conditions, but decreased since then reflecting the installation of flue gas desulfurization controls at coal-fired electric generating stations and a reduction in the average sulfur content of fuels consumed. Emissions from other stationary source fuel combustion sectors also declined, mainly due to decreased combustion of coal by these consumers. Sulfur oxide emissions from industrial processes are also significant. Emissions from industrial processes have declined, primarily as the result of controls implemented to reduce emissions from nonferrous smelters and sulfuric acid manufacturing plants.[7]

The disparity between the 36 percent decrease in SO_2 air quality and the 16 percent decrease in SO_2 emissions can be attributed to several factors. SO_2 monitors are mostly urban population-oriented and as such do not monitor many of the major emitters which tend to be located in more rural areas. Among the 229 trend sites used in the analysis of average SO_2 levels, 67 percent are categorized as population-oriented. The remaining sites include those monitors in the vicinity of large power plants, nonferrous smelters and other industrial sources such as paper mills and steel producing facilities.

The residential and commercial areas, where most monitors are located, have shown sulfur oxide emission decreases comparable to SO_2 air quality improvement. These decreases in sulfur oxide emissions are due to a combination of energy conservation measures and the use of cleaner fuels in the residential and commercial areas.[7]

Although one-third of the trend sites are categorized as source-oriented, the majority of SO_2 emissions are dominated by large point sources. Two-thirds of all national SO_2 emissions are generated by electric utilities (94 percent of which come from coal fired power plants). The majority of these emissions, however, are produced by a small number of facilities. Fifty-three individual plants in 14 states account for one-half of all power plant emissions.[15] In addition, the 200 highest SO_2 emitters account for more than 85 percent of all SO_2 power plant emissions.[15,16] These 200 plants account for 57 percent of all SO_2 emissions, nationally.

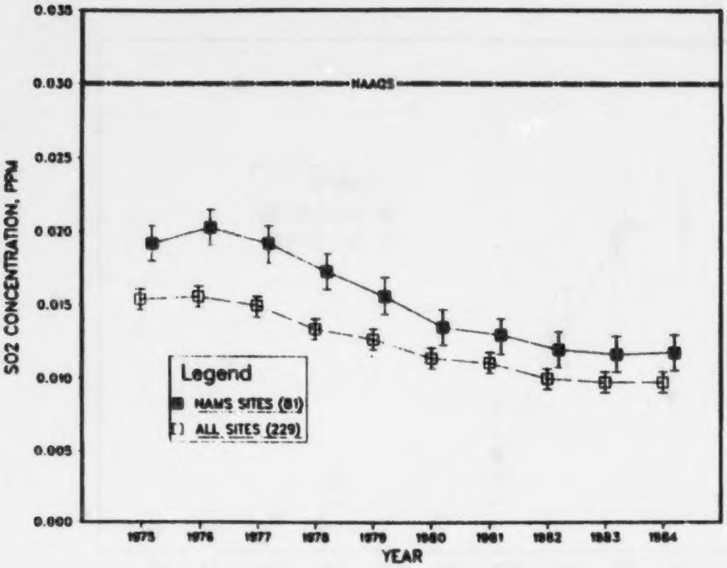


Figure 3-9. National trend in the composite average of the annual average sulfur dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

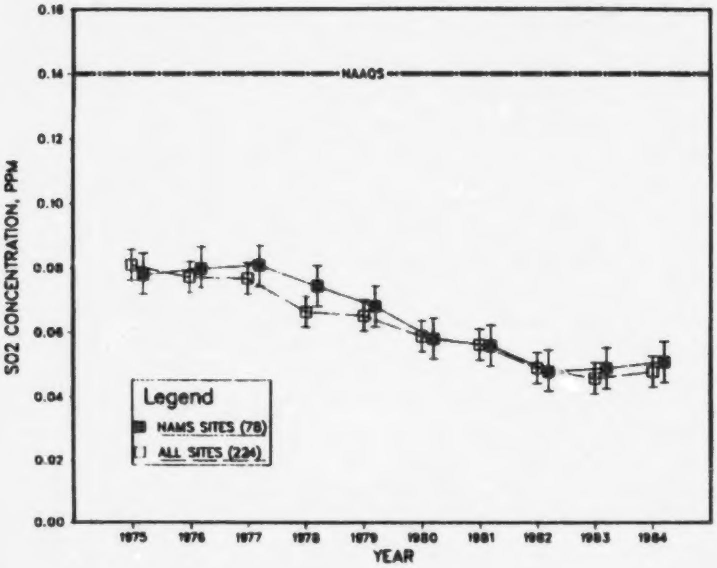


Figure 3-10. National trend in the composite average of the second-highest 24-hour sulfur dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

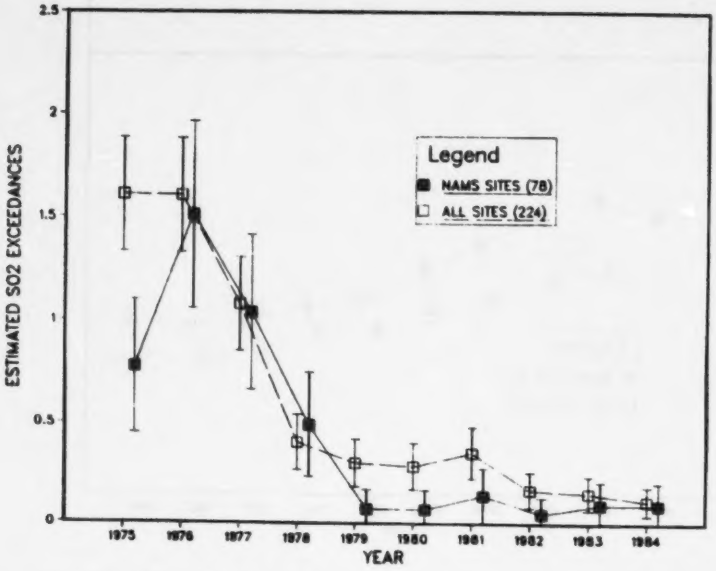


Figure 3-11. National trend in the composite average of the estimated number of exceedances of the 24-hour sulfur dioxide NAAQS at both NAMS and all sites with confidence intervals, 1975-1984.

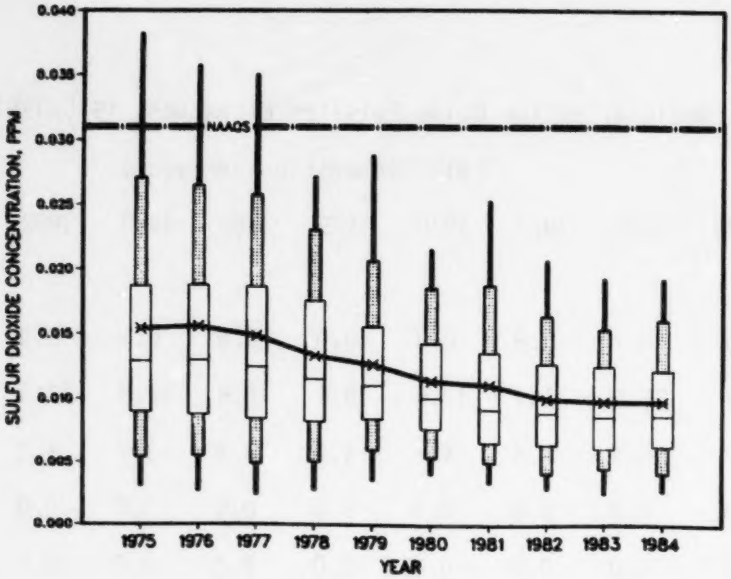


Figure 3-12. Boxplot comparisons of trends in annual mean sulfur dioxide concentrations at 229 sites, 1975-1984.

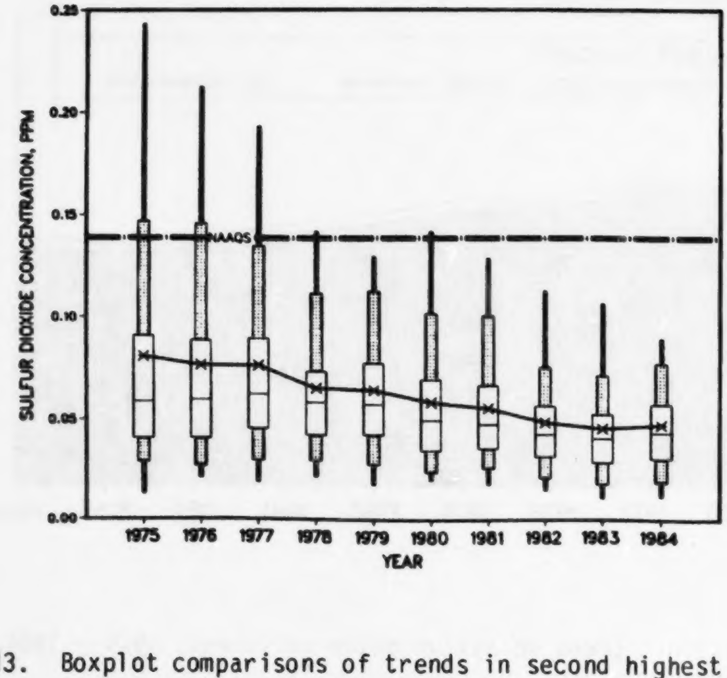


Figure 3-13. Boxplot comparisons of trends in second highest 24-hour average sulfur dioxide concentrations at 224 sites, 1975-1984.

Table 3-2. National Sulfur Oxide Emission Estimates, 1975-1984.

(million metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Transportation	0.6	0.7	0.8	0.8	0.9	0.9	0.8	0.8	0.8	0.9
Fuel Combustion	20.3	20.9	21.1	19.6	19.4	18.8	17.8	17.3	16.7	17.3
Industrial Processes	4.7	4.6	4.4	4.1	4.2	3.5	3.7	3.2	3.1	3.1
Solid Waste	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miscellaneous	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	25.6	26.2	26.3	24.5	24.5	23.2	22.3	21.3	20.6	21.4

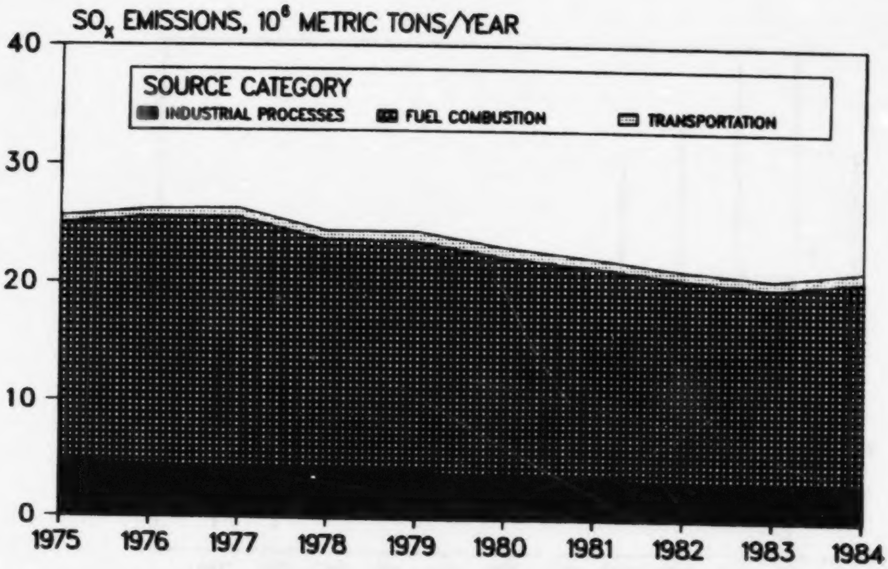


Figure 3-14. National trend in sulfur oxide emissions, 1975 - 1984.

Another factor which may account for differences in SO_2 emissions and ambient air quality is stack height. The height at which SO_2 is released into the atmosphere has been increasing at industrial sources and power plants.[17,18] This can permit ground level concentrations to decrease at a faster rate than emissions. Under these circumstances, concentrations can, in fact, decrease even if emissions increase.

The influence of particular source reductions on air quality is presented for nonferrous smelters. These sources represent a majority of SO_2 emissions in the intermountain region of the western U.S. (from the Sierra crest to the continental divide). Monitors in the vicinity of smelters tend to produce some of the highest SO_2 concentrations observed nationally. Figure 3-15 compares the SO_2 air quality and emission trends for smelters. It shows that these SO_2 concentrations, represented by 17 monitoring sites, are higher and decreased at a substantially faster rate than SO_2 nationally. The smelter sites have experienced a 52 percent decrease in ambient concentrations, corresponding to a 55 percent decrease in smelter emissions. The smelter decrease is attributed to cutbacks in production or plant closings. Both smelter trends track very well and show the increase in 1981 for both emissions and ambient air quality which was recently reported by Opperheimer et. al. for SO_2 emissions and western U.S. Regional sulfate concentrations.[19]

3.2.2. Recent SO_2 Trends: 1980-84

Figure 3-16 presents a comparison of long and short-term SO_2 trends for annual mean concentrations. The boxplot display for the 1980-1984 data, based on 477 sites, indicate a similar decrease over the same 5-year period included in the long-term trends, but with lower average concentrations. This is attributed to inclusion of new SO_2 monitoring sites in areas with medium to low concentration levels. The 5-year trend shown in Figure 3-16 matches the national emission trend in Figure 3-14. In particular, 1983 had the lowest SO_2 levels. Air quality levels increased 2 percent while emissions increased 4 percent. The small increases from 1983 to 1984 may be attributed to an increase in fuel combustion, which was only partially offset by new SO_2 controls.

Regional changes in composite average SO_2 concentrations for the last 3 years, 1982-1984 are shown in Figure 3-17. Although most Regions increased slightly between 1983 and 1984, annual changes are small and no consistent pattern is apparent nationwide over the last 3 years. The southern and western Regions (Regions IV, VI, VIII, and IX) maintain their status of recording the lowest overall average concentrations in recent years.

Although these Regions display relatively low overall average concentrations, they also contain some of the highest SO_2 concentrations recorded nationally. This phenomenon which is due to SO_2 in the vicinity

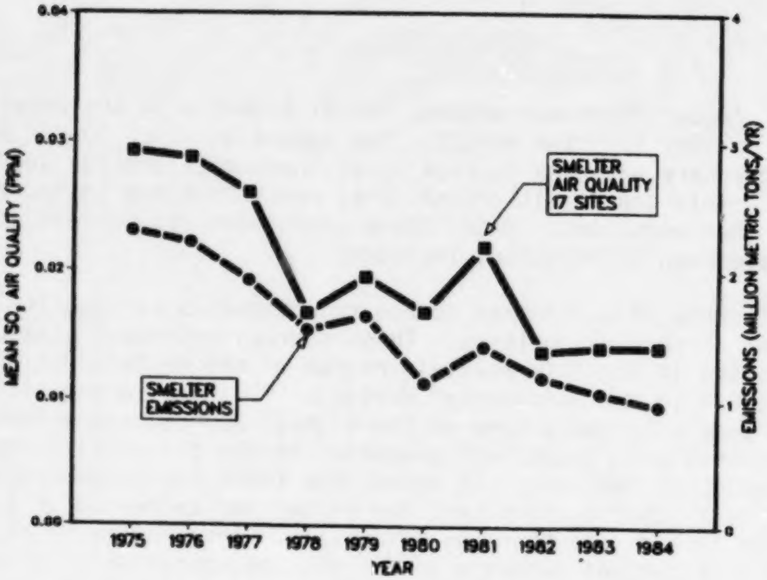


Figure 3-15. National smelter emissions vs. air quality trends, 1975-1984.

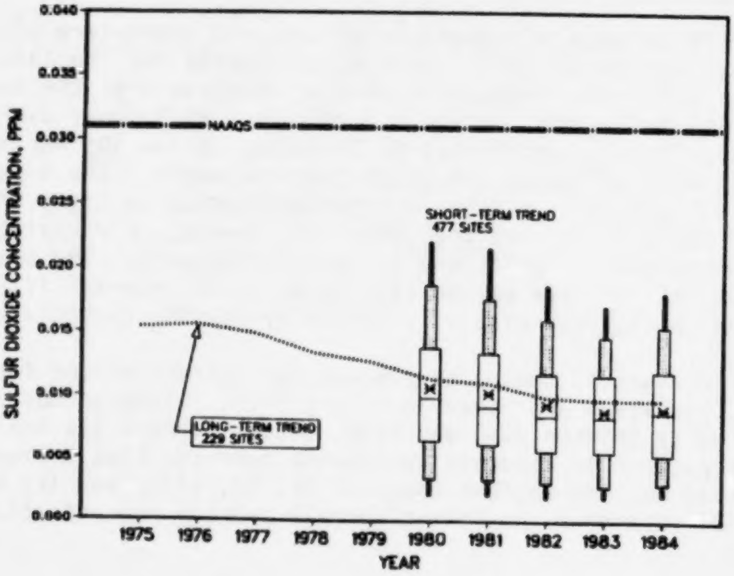


Figure 3-16. Comparison of long-term and recent trends in annual average sulfur dioxide concentrations.

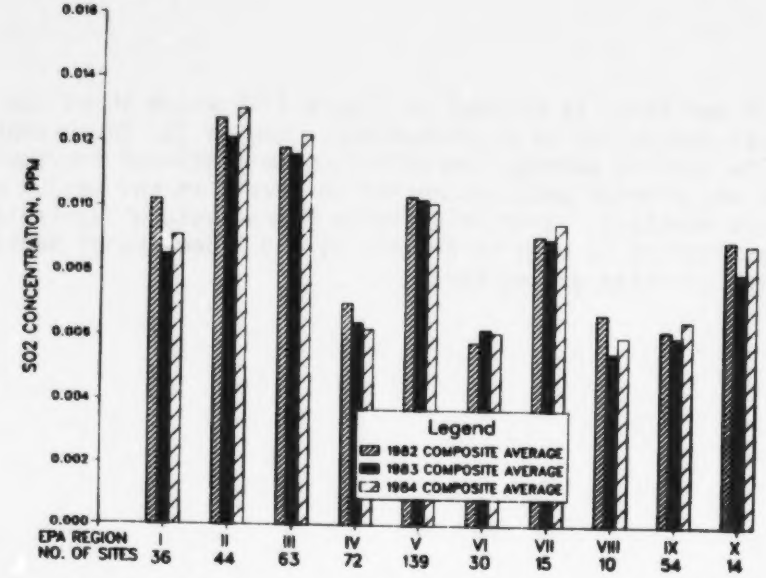


Figure 3-17. Regional comparison of the 1982, 1983, 1984 composite average of the annual average sulfur dioxide concentration.

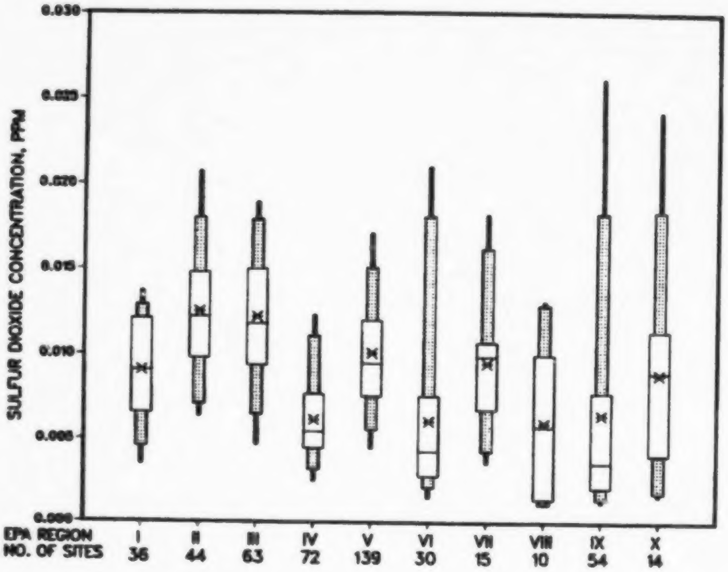


Figure 3-18. Regional boxplot comparisons of the annual average sulfur dioxide concentrations in 1984.

of nonferrous smelters, is evident in Figure 3-18 which shows the 1984 intra-regional concentration distributions. Region IX, for example, displays a low overall average concentration as mentioned previously, but also has the highest peak concentration levels in the Nation because of the Arizona smelters. Similarly, large intra-regional variability in SO_2 concentrations is seen in Regions VI and X because of monitors located in the vicinity of smelters.

3.3 TRENDS IN CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless, and poisonous gas produced by incomplete burning of carbon in fuels. Over two-thirds of of the nationwide CO emissions are from transportation sources and highway motor vehicle are the largest contributing source of these CO emissions. The NAAQS for ambient CO specifies upper limits that are not to be exceeded more than once per year for two different averaging times: a 1-hour level of 35 ppm and an 8-hour level of 9 ppm. Because the 8-hour standard is generally more restrictive, this trends analysis emphasizes the 8-hour average results.

The trends site selection process, discussed in Section 2.1, resulted in a data base of 157 sites for the 1975-84 long-term period and a data base of 309 sites for the 1980-84 recent trends time period. Forty of the long-term trends sites were NAMS while 90 NAMS qualified for inclusion in the recent trends data base. This approximate doubling of the data base between the long-term and recent trends time periods is indicative of the improvement in size and stability of current ambient CO monitoring programs.

3.3.1 Long-term CO Trends: 1975-84

Figure 3-19 presents the national 1975-84 composite average trend for the second highest non-overlapping 8-hour CO value for the 157 long-term trend sites and the subset of 40 NAMS sites. The national composite decreased by 34 percent between 1975 and 1984, while there was a 30 percent decrease for the NAMS subset. Although the median rate of improvement has been approximately 5 percent per year, this rate is less pronounced in the last few years. The confidence intervals in Figure 3-19 show that ambient concentrations in the more recent years are significantly less than the earlier years. During this time period, 87 percent of the trend sites showed long-term improvement.

Figure 3-20 displays the same trend but uses the boxplot presentation to provide more information on the distribution of ambient CO levels from year to year at the 157 long-term trend sites. The general long-term improvement is evident although certain percentiles show year to year fluctuations.

The long-term composite average trend in the estimated number of exceedances of the 8-hour CO NAAQS is shown in Figure 3-21. This exceedance rate was adjusted to account for incomplete sampling and the pattern is generally consistent with the trends in the second maximum i.e. long-term improvement followed by a levelling off in the past few years. The rate of improvement is more pronounced for this exceedance statistic with an 88 percent decrease between 1975 and 1984 for the 157 site data base and a 79 percent decrease for the subset of 40 NAMS. The NAMS sites show a recent increase but, as indicated by the confidence intervals, this is not statistically significant.

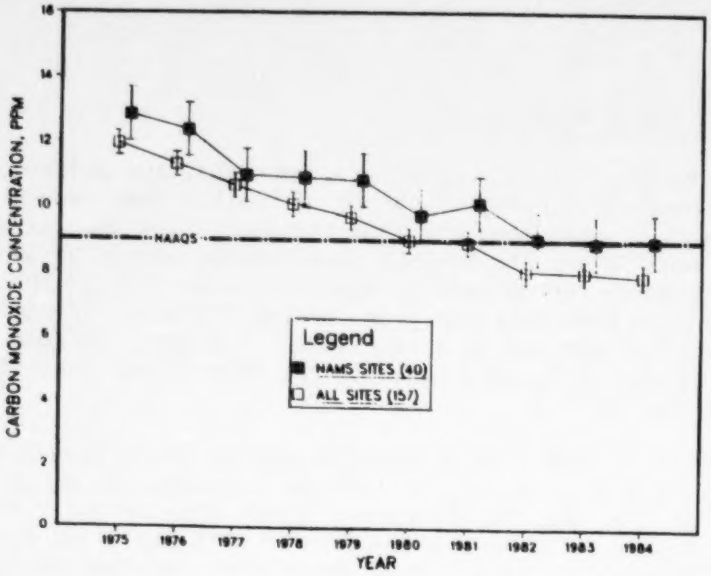


Figure 3-19. National trend in the composite average of the second highest nonoverlapping 8-hour average carbon monoxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

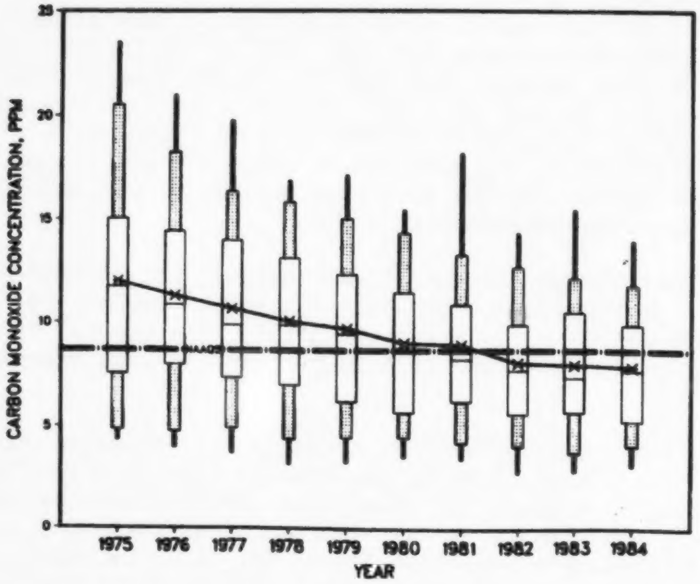


Figure 3-20. Boxplot comparisons of trends in second highest nonoverlapping 8-hour average carbon monoxide concentrations at 157 sites, 1975-1984.

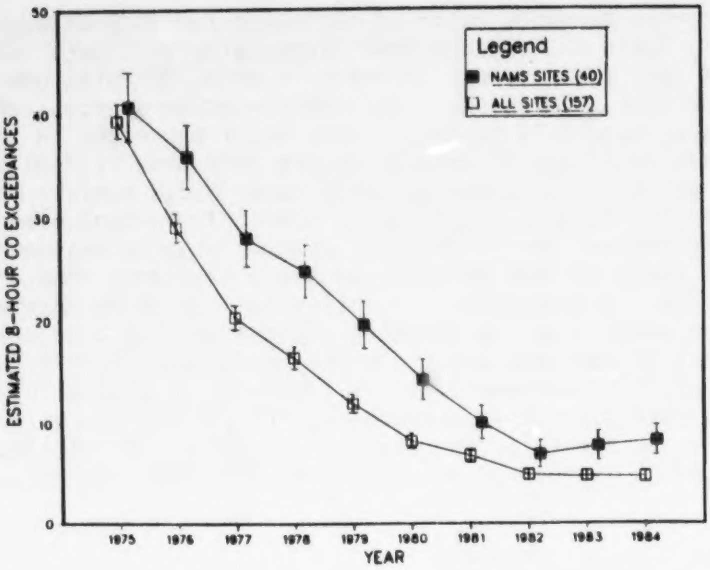


Figure 3-21. National trend in the composite average of the estimated number of exceedances of the 8-hour carbon monoxide NAAQS, at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

National carbon monoxide emission estimates for 1975 through 1984 are presented in Table 3-3 and depicted graphically in Figure 3-22.[7] These estimates show a 14 percent decrease in total CO emissions between 1975 and 1984. Emissions from transportation sources, which account for approximately 70 percent of the total emissions in 1984, are estimated to have decreased 22 percent during this same 1975-84 time period. These emission decreases occurred even though vehicle miles of travel are estimated to have increased by almost 30 percent over this time period. Therefore, the CO emission control program has been effective on the national scale in that emission controls have more than offset growth during this period. In comparing air quality and emission changes for CO, it should be noted that the emission changes reflect national totals while the ambient CO monitors are typically located to identify potential problems. Therefore, these monitors are likely to be placed in traffic saturated areas that may not experience significant increases in vehicle miles of travel. As a result, the air quality levels at such locations would be expected to improve at a faster rate than the nationwide reduction in emissions.

3.3.2 Recent CO Trends: 1980-84

Figure 3-23 uses an expanded data set to display ambient CO trends for the 1980-84 period in terms of the second highest non-overlapping 8-hour averages. As noted in Section 2.1, the larger data set, 309 versus 157 sites, is a result of restricting the historical data completeness criterion to only the 1980's so that newer monitoring sites can qualify for inclusion. In Figure 3-23, the previously discussed long-term composite average for the 157 long-term trends sites is superimposed on a boxplot presentation for the 309 sites used for recent trends. There is less than a 5 percent difference between the composite averages of the two data sets and there is general agreement in the trends. Both data sets show consistent year to year improvement but the rate of improvement appears to be decreasing. The recent trends data shows a 10 percent improvement between 1980 and 1984 but the improvement between 1983 and 1984 was only 1 percent. This recent leveling off in air quality appears to be consistent with the CO emissions presented in Table 3-3. For example, while the transportation category showed a 22 percent decrease between 1975 and 1984, there has been less than a 1 percent change between 1982 and 1984. Although not presented explicitly in Table 3-3, the highway vehicle portion of the transportation category is estimated to have decreased by 1 percent between 1983 and 1984.

Year-to-year changes in composite regional averages for 1982-84 are shown in Figure 3-24. With the levelling off in CO improvement that was seen for the most recent years, it is not surprising that regional patterns are mixed. It should be noted that these regional graphs are primarily intended to depict relative change during this time period and not typical levels in each Region. Because the mix of monitoring sites may vary from one area to another, with one set of sites dominated by center-city monitors in large urban areas while another set of sites may represent a more diversified mix, this graph is not intended to be indicative of regional differences in absolute concentration levels.

Table 3-3. National Carbon Monoxide Emission Estimates, 1975-1984.

(million metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Transportation	62.0	64.3	61.1	60.4	55.9	52.7	51.6	48.1	48.4	48.5
Fuel Combustion	4.4	4.7	5.2	5.8	6.6	7.4	7.5	8.0	8.0	8.3
Industrial Processes	6.9	7.1	7.2	7.1	7.1	6.3	5.9	4.4	4.4	4.9
Solid Waste	3.1	2.7	2.6	2.5	2.3	2.2	2.1	2.0	1.9	1.9
Miscellaneous	4.8	7.1	5.8	5.7	6.5	7.6	6.4	4.9	7.7	6.3
Total	81.2	85.9	81.9	81.5	78.4	76.2	73.5	67.4	70.4	69.9

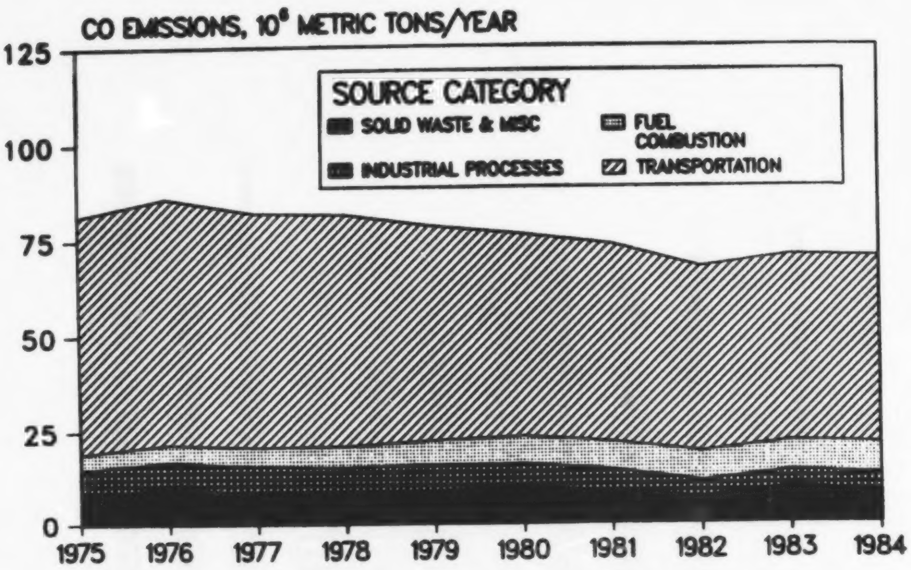


Figure 3-22. National trend in emissions of carbon monoxide, 1975-1984.

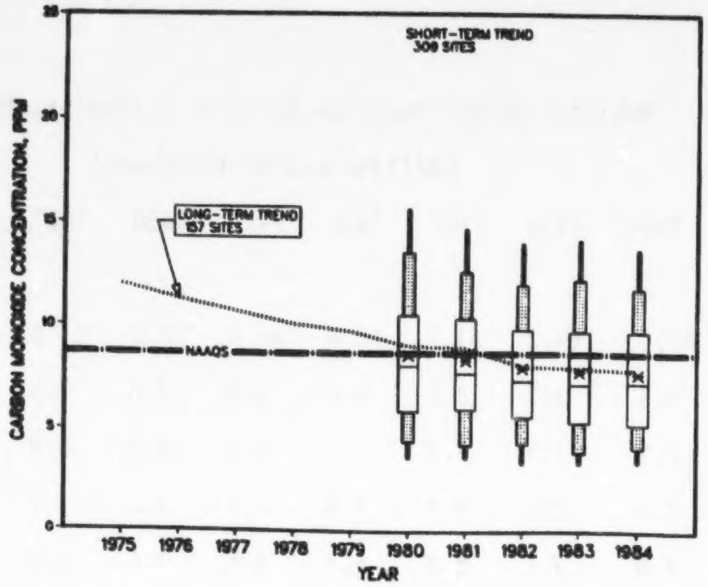


Figure 3-23. Comparison of long-term and recent trends in second highest nonoverlapping 8-hour average carbon monoxide concentrations.

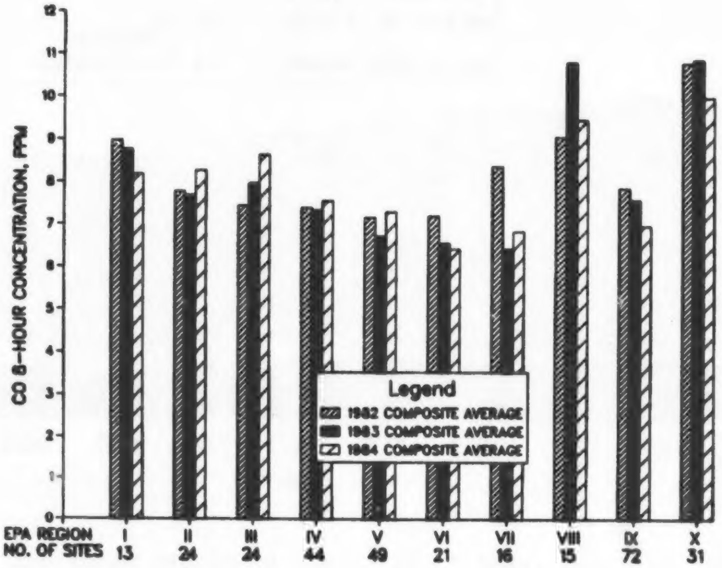


Figure 3-24. Regional comparison of the 1982, 1983, 1984 composite average of the second highest nonoverlapping 8-hour average carbon monoxide concentration.

3.4 TRENDS IN NITROGEN DIOXIDE

Nitrogen dioxide (NO_2), a yellowish, brown gas, is present in urban atmospheres through emissions from two major sources; transportation and stationary fuel combustion. The major mechanism for the formation of NO_2 in the atmosphere is the oxidation of the primary air pollutant, nitric oxide. NO_2 is measured using either a continuous monitoring instrument, which can collect as many as 8760 hourly values a year, or a 24-hour bubbler, which collects one measurement per 24-hour period. Both monitors are used to compare annual average concentrations with the NO_2 standard of 0.053 parts per million.

In order to expand the size of the available trends data base, data were merged at sites which experienced changes in the agency operating the site, the instrument used, or the designation of the project code, such as population oriented or duplicate sampling. The merging was accomplished by treating the bubbler and continuous hourly data separately. For example, if a monitor at a given site was changed from a 24-hour bubbler to a continuous hourly monitor, the data would not be merged. If, however, a monitor at a given site changed from one type of continuous instrument to another type of continuous instrument, the data would be merged.

The trends site selection process, described in Section 2.1, yielded 119 sites for the 1975-84 long-term period and 236 sites for the 1980-84 recent trends data base. Twelve of the long-term trend sites are NAMS while 36 NAMS are included in the 1980-84 data base. The size of the long-term data base has been decreasing each successive year as low concentration sites are discontinued or as NO_2 bubblers are replaced with continuous instruments. In this latter case, data from these two different methods are not merged.

3.4.1 Long-term NO_2 Trends: 1975-84

The composite average long-term trend for the nitrogen dioxide mean concentration at the 119 trend sites, and the 12 NAMS sites, is shown in Figure 3-25. Nationally, at all sites, annual average NO_2 levels increased from 1975 to 1979, decreased through 1983 and then recorded a slight increase in 1984. However, the 1984 composite average NO_2 level is 10 percent lower than the 1975 level, indicating a downward trend during this period. Of the 119 trends sites, only 12 are designated as NAMS. This is to be expected because NO_2 does not present a significant air quality problem in most areas at this time. Also, NAMS for NO_2 are only located in urban areas of populations of 1,000,000 or greater. Except for 1980, the composite averages of the NAMS are higher than those of all sites. Comparing 1984 data to the 1975 levels shows a 10 percent decrease in the composite average for all trends sites and a 12 percent decrease for the NAMS. The discrepancy between the all sites and NAMS year to year changes may be attributed to both the small number of NAMS meeting the long-term trends criteria and the generally low levels of recorded NO_2 annual mean concentrations.

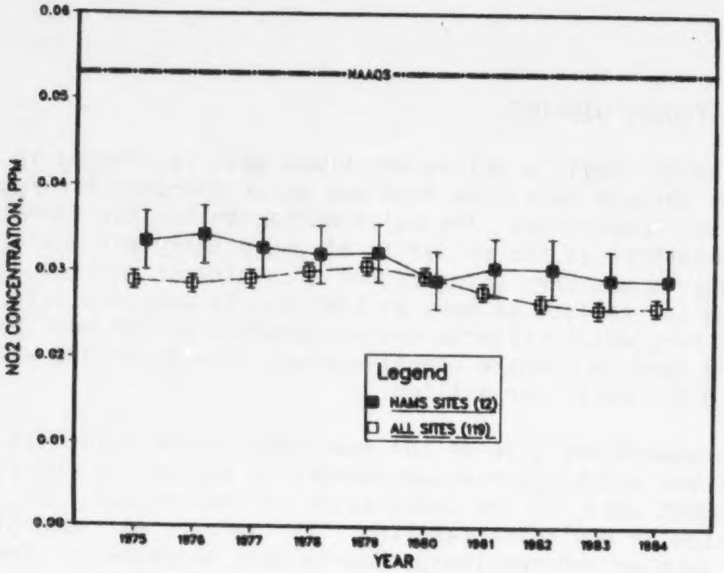


Figure 3-25. National trend in the composite average of nitrogen dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

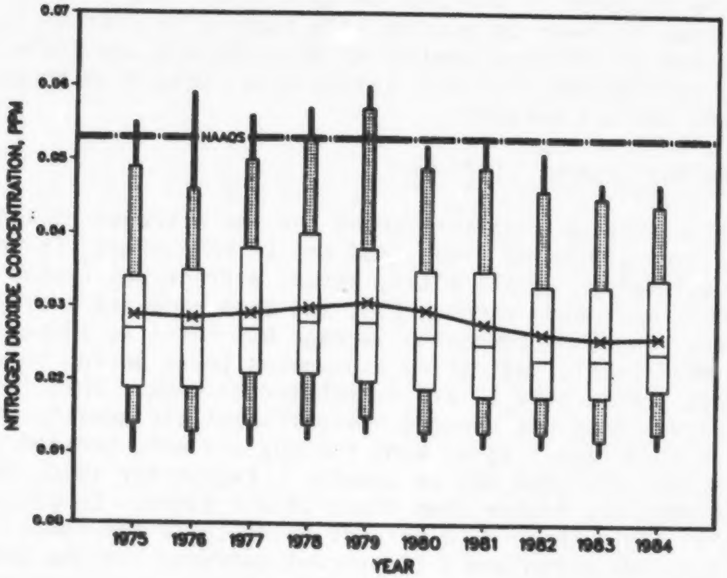


Figure 3-26. Boxplot comparisons of trends in annual mean nitrogen dioxide concentrations at 119 sites, 1975-1984.

In Figure 3-25, the 95 percent confidence intervals about the composite means allow for comparisons among the years. While there are no significant differences among the years for the NAMS, because there are so few sites meeting the historial trends criteria, there are significant differences among the composite means of the 119 long-term trends sites. Although the 1983 and 1984 composite mean NO_2 levels are not significantly different from one another, they are significantly less than the earlier years 1978, 1979 and 1980.

Long-term trends in NO_2 annual average concentrations are also displayed in Figure 3-26 with the use of boxplots. The improvement in the composite average between 1979 and 1984 can also be seen in the the upper percentiles. The lower percentiles show little change, however.

The trend in the estimated nationwide emissions of nitrogen oxides (NO_x) is similar to the NO_2 air quality trend. Table 3-4 shows NO_x emissions increasing from 1975 through 1979 and generally decreasing until 1984. Between 1975 and 1984 total nitrogen oxide emissions increased by 3 percent, but highway vehicle emissions, the source category likely impacting the majority of NO_2 sites, decreased by 4 percent. Figure 3-27 shows that the two primary source categories of nitrogen oxide emissions are fuel combustion and transportation.

3.4.2 Recent NO_2 Trends: 1980-84

Figure 3-28 uses the boxplot presentation to display recent trends in nitrogen dioxide annual mean concentrations for the years 1980-84. Focusing on the past five years, rather than the last ten years, almost doubles the number of sites, from 119 to 236, available for the analysis. Superimposed upon this presentation is the long-term NO_2 trend line from the period 1975-84. As indicated by this figure, although the composite means from the recent period are lower than the long-term means, the trends are consistent for the two data bases.

The recent trend in the composite average of NO_2 concentrations at both NAMS and all sites is shown in Figure 3-29 with 95 percent intervals about the composite mean. The composite average NO_2 level at the 236 trend sites decreased 7 percent between 1980 and 1984. During this same period, nitrogen oxide emissions decreased by 3 percent. Between 1983 and 1984, the NO_2 composite average increased 2 percent, while nitrogen oxide emissions recorded a 3 percent increase. In contrast to the 1975-84 data base, the recent 5-year trends data base shows greater consistency between the NAMS and all sites trends. The subset of 33 NAMS show higher composite mean levels than the 236 sites in the data base. However, neither site group recorded significantly different NO_2 composite average levels during the last 3 years.

Regional trends in the composite average NO_2 concentrations for the years 1980-84 are displayed in Figure 3-30 using bar graphs. As indicated in the figure, Regions I through III, V and IX consistently record the highest composite averages. The pattern of the year-to-year changes is mixed among the regions, however, eight of the ten Regions showed increases between 1983 and 1984.

Table 3-4. National Nitrogen Oxide Emission Estimates, 1975-1984

(million metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Transportation	8.9	9.3	9.5	9.7	9.6	9.2	9.3	8.9	8.6	8.7
Fuel Combustion	9.4	10.0	10.5	10.3	10.5	10.2	10.2	10.0	9.6	10.1
Industrial Processes	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.6	0.6
Solid Waste	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Miscellaneous	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2
Total	19.2	20.3	21.0	21.0	21.1	20.4	20.5	19.7	19.1	19.7

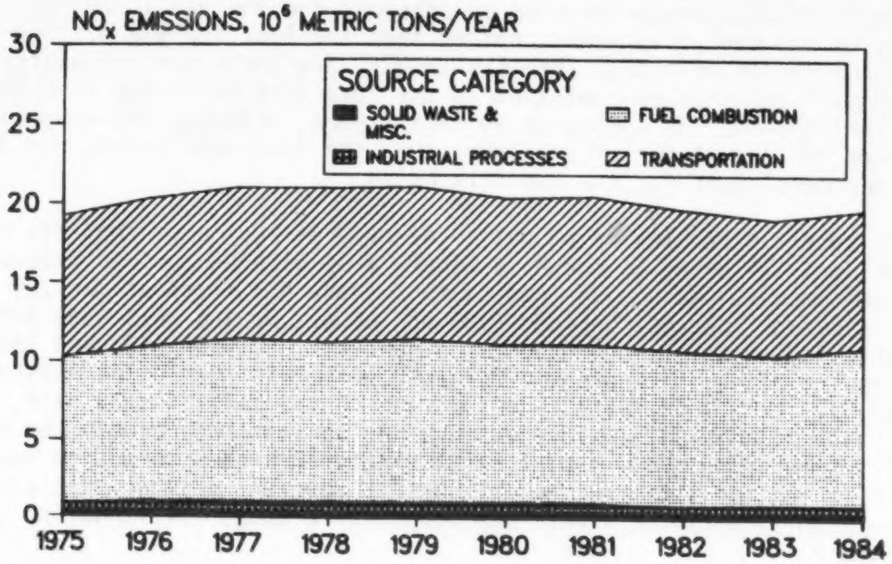


Figure 3-27. National trend in emissions of nitrogen oxides, 1975-1984.

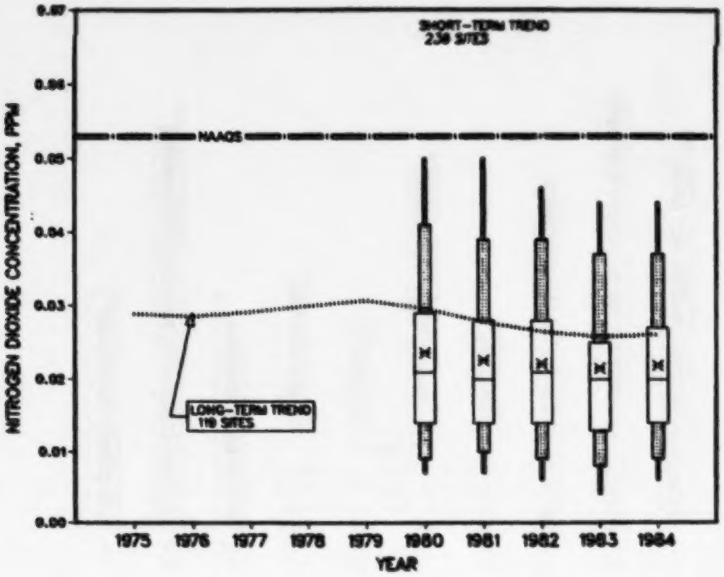


Figure 3-28. Comparison of long-term and recent trends in annual mean nitrogen dioxide concentrations.

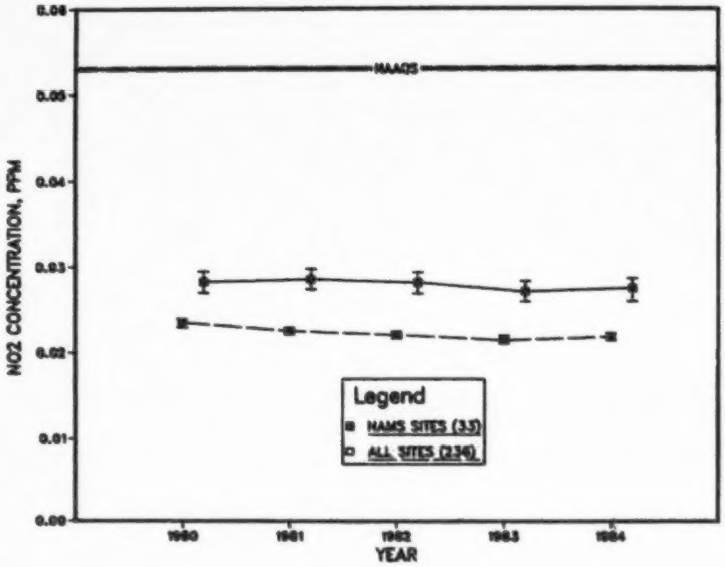


Figure 3-29. National trend in the composite average of nitrogen dioxide concentration at both NAMS and all sites with 95 percent confidence intervals, 1980-84.

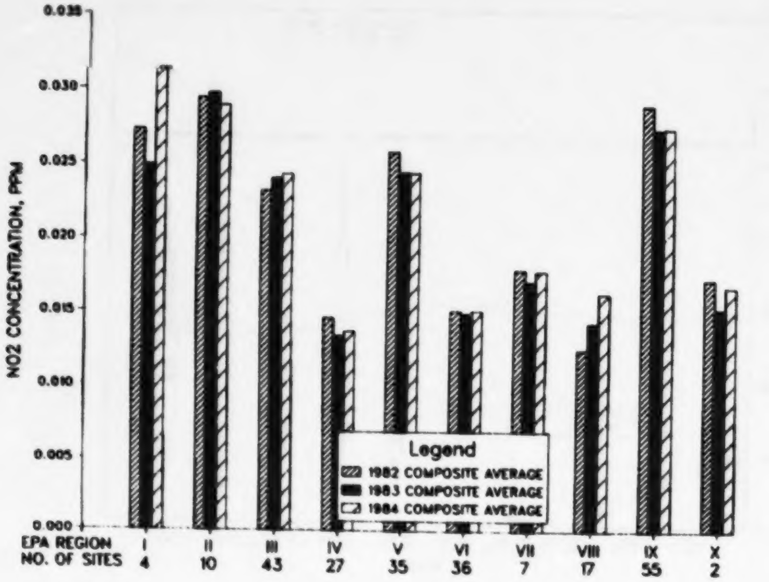


Figure 3-30. Regional comparison of the 1982, 1983, 1984 composite average of the annual mean nitrogen dioxide concentration.

3.5 TRENDS IN OZONE

Ozone (O_3) is a major pollution concern for large urban areas throughout the Nation. In contrast to the other criteria pollutants described in this report, ozone is not emitted directly by specific sources but is formed in the air by chemical reactions between nitrogen oxides and volatile organic compounds. These come from sources such as gasoline vapors, chemical solvents, and combustion products of various fuels. Because these reactions are stimulated by sunlight and temperature, peak ozone levels typically occur during the warmer times of the year. The strong seasonal patterns for ozone make it possible for areas to concentrate their ozone monitoring during a certain portion of the year, termed the ozone season. The length of the ozone season varies from one area of the country to another. While May through October is fairly typical, States in the south and southwest may monitor the entire year while the more northern States would have a shorter season, such as May through September for North Dakota. This trends analysis uses these O_3 seasons on a State basis to ensure that the data completeness requirements are applied to the relevant portions of the year.

The NAAQS for O_3 is defined in terms of the daily maximum, that is, the highest hourly value for the day, and specifies that the expected number of days per year with values greater than 0.12 ppm should not be greater than one. Both the annual second highest daily maximum and the number of daily exceedances during the ozone season are considered in this trends analysis.

The trends sites selection process, discussed in Section 2.1, resulted in 163 sites being selected for the 1975-84 long-term period and 480 sites qualifying for the 1980-84 recent trends data base. Sixty of the long-term trends sites were NAMS while 175 NAMS sites were included in the recent trends data base. For the NAMS and all sites, the recent trends data base is approximately three times larger than the long-term trends data base. This is consistent with the expected improvement in the size and stability of current ambient ozone monitoring networks.

3.5.1 Long-term O_3: 1975-84

The composite average long-term trend for the second high day during the ozone season is shown in Figure 3-31 for the 163 trends sites and the subset of 60 NAMS. Although the 1984 composite average for the 163 trends sites is 17 percent lower than the 1975 average, the interpretation of this decrease is complicated by a calibration change for ozone measurements that occurred in the 1978-79 time period.[20] The stippled portion of the Figure indicates data affected by measurements taken prior to the calibration change. As noted in earlier reports, it is difficult to quantify exactly how much of the 1978-79 decrease is due to the calibration change.[10] Not all agencies made the change at the same time and, in fact, for some States such as California the 1975-78 data already accounted for the change resulting from the new calibration procedure. Therefore, trend comparisons involving data prior to 1979 should be viewed with caution and an awareness of the affect of the calibration change. Comparing the 1984 data with 1979 shows a 7 percent decrease in the composite average for all trends sites and also for the subset of NAMS. However, the general trend has been somewhat mixed as discussed in the following section on recent trends.

Long-term ozone trends are also displayed in Figures 3-32 and 3-33. Figure 3-32 uses the boxplot presentation for the annual second highest daily maximum while Figure 3-33 presents the composite average number of ozone exceedances. This latter statistic is adjusted for missing data and reflects the number of days that the level of the ozone standard is exceeded during the ozone season. Again, the stippled area indicates the time period when comparisons would be affected by the calibration change so that the 62 percent decrease in the number of exceedances between 1975 and 1984 incorporates the effect of the calibration change. Between 1979 and 1984 the expected number of exceedances decreased 36 percent at the 163 trends sites with a decrease of 32 percent at the subset of NAMS sites. Both Figures 3-31 and 3-33 illustrate the agreement between the trends at the NAMS sites and those for the larger data base.

Table 3-5 and Figure 3-34 display the 1975-84 emission trends for Volatile Organic Compounds (VOC) which, along with nitrogen oxides, are involved in the atmospheric chemical and physical processes that result in the formation of O_3. Total VOC emissions are estimated to have decreased 6 percent between 1975 and 1984.[7] As shown in Table 3-5 the annual total for each year of the 1980's is less than the annual totals for the 1975-79 period. Emissions from transportation sources decreased by 30 percent during the 1975-84 period even though vehicle miles of travel increased by 29 percent. Fuel combustion VOC emissions showed consistent growth accounting for less than 5 percent of the total emissions in 1975 but more than 10 percent of the total in 1984. The more recent emission patterns are discussed in the following section.

3.5.2 Recent O_3 Trends: 1980-84

Focusing on ozone trends in the 1980's permits the use of a larger data base that reflects the improved status of current ambient monitoring networks. Figure 3-35 uses a boxplot presentation for the short-term ozone trends data base and also displays the previously discussed long-term trends. Trends in the 1980's are reasonably consistent for both data bases although the composite average and median are slightly lower for the larger data base. The short-term data base showed a 9 percent improvement for the national composite average second maximum. The basic pattern, for both data sets, is that 1980 and 1983 values were higher than those in 1981, 1982, and 1984. The previously reported

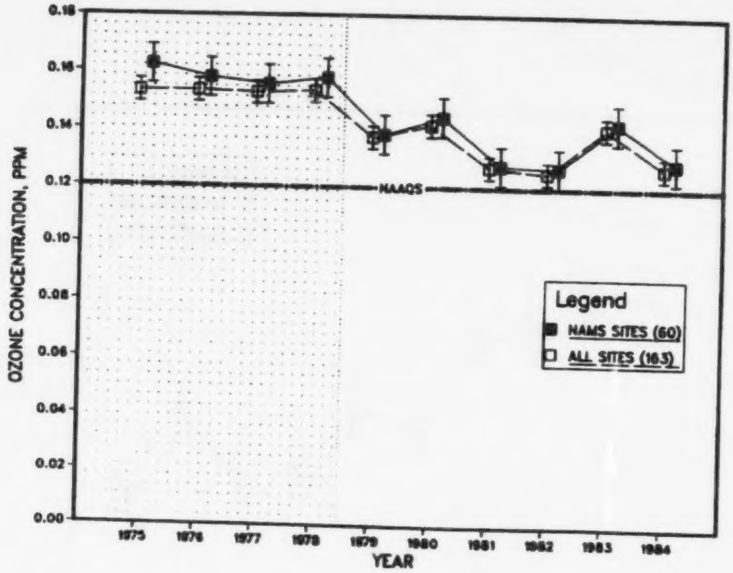


Figure 3-31. National trend in the composite average of the second highest maximum 1-hour ozone concentration at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

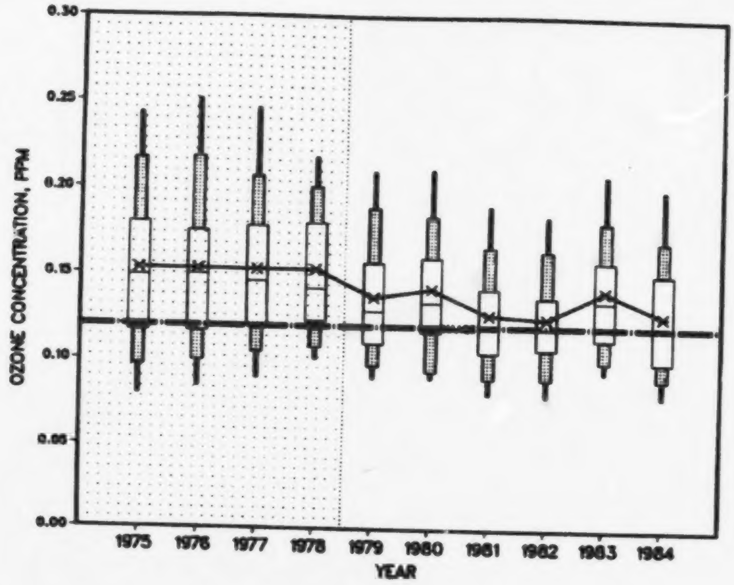


Figure 3-32. Boxplot comparisons of trends in annual second highest daily maximum 1-hour ozone concentrations at 163 sites, 1975-1984.

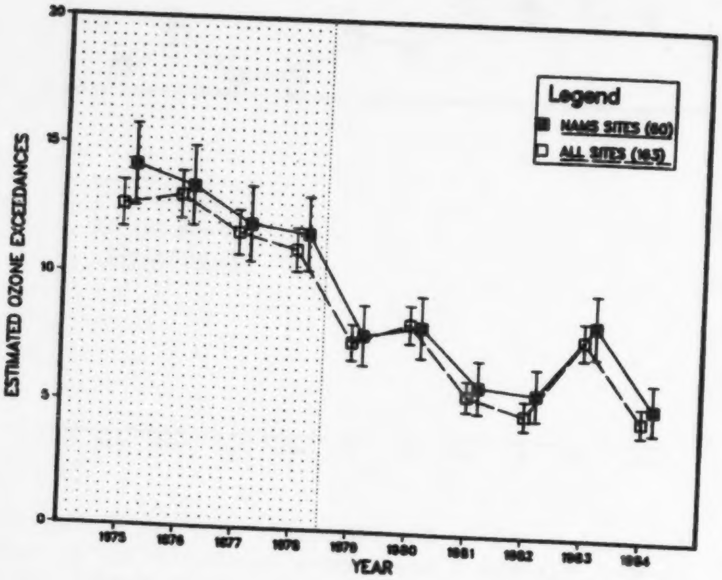


Figure 3-33. National trend in the composite average of the estimated number of daily exceedances of the ozone NAAQS in the ozone season at both NAMS and all sites with 95 percent confidence intervals, 1975-1984.

Table 3-5. Volatile Organic Compound National Emission Estimates, 1975-1984.

(million metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Transportation	10.3	10.4	10.0	9.8	8.9	8.2	8.0	7.5	7.2	7.2
Fuel Combustion	1.0	1.2	1.4	1.6	1.9	2.1	2.3	2.5	2.5	2.6
Industrial Processes	8.1	8.7	9.0	9.6	9.5	8.9	8.0	7.1	7.5	8.4
Nonindustrial Organic Solvent Use	1.9	1.9	1.9	1.9	2.0	1.9	1.6	1.5	1.6	1.8
Solid Waste	0.9	0.8	0.8	0.8	0.7	0.6	0.6	0.6	0.6	0.6
Miscellaneous	0.6	1.0	0.8	0.8	0.9	1.0	0.9	0.7	1.1	0.9
Total	22.8	24.0	23.9	24.5	23.9	22.7	21.4	19.9	20.5	21.5

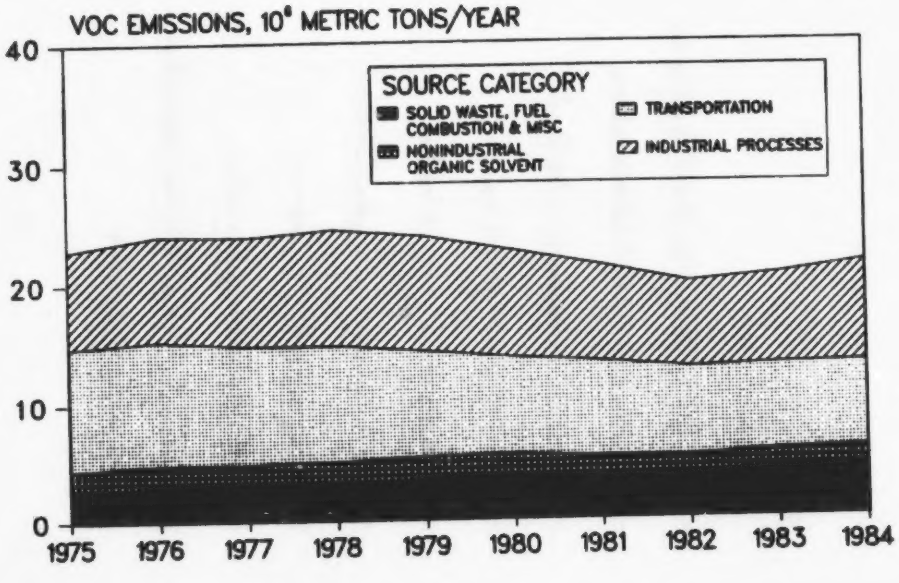


Figure 3-34. National trend in emissions of volatile organic compounds, 1975-1984.

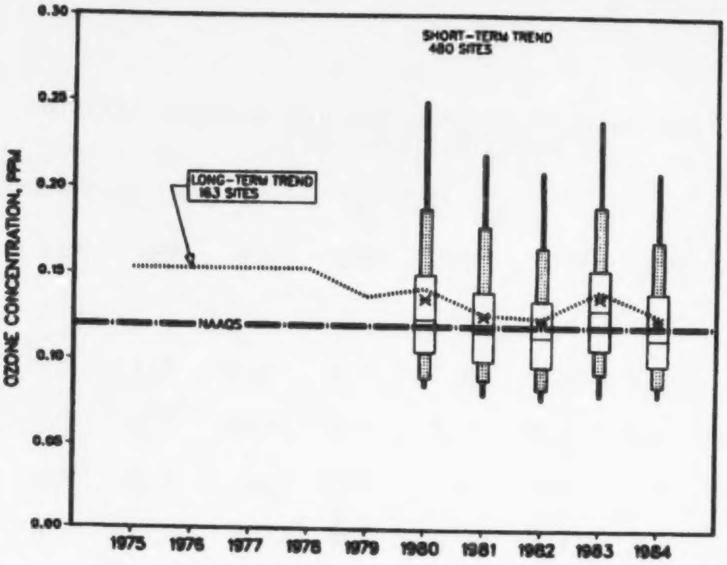


Figure 3-35. Comparison of long-term and recent trends in annual second highest daily maximum 1-hour ozone concentrations.

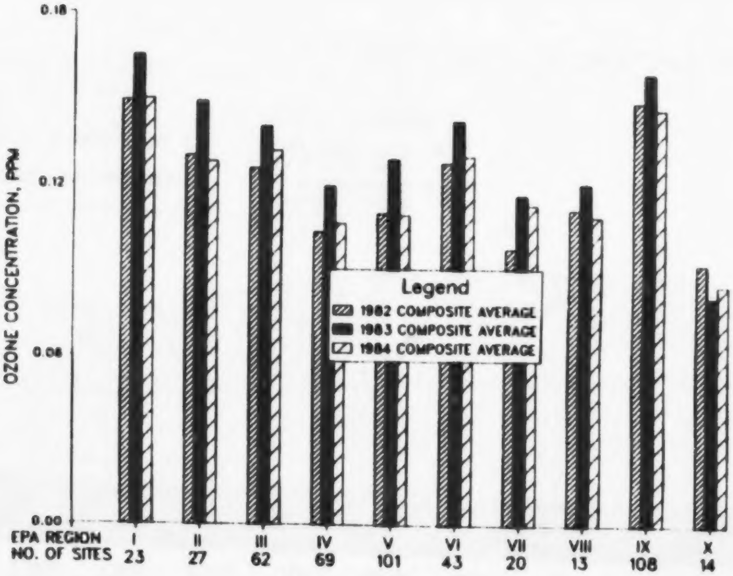


Figure 3-36. Regional comparison of the 1982, 1983, 1984 composite average of the second-highest daily 1-hour ozone concentration.

increase between 1982 and 1983 was followed by a decrease of approximately 10 percent between 1983 and 1984 so that the 1984 values are similar to those reported in 1981 and 1982.[10] At approximately one-third of these sites, the 1984 value was the lowest annual second maximum for the 1980's, while only 10 percent had their highest value for the 1980's in 1984.

As noted in last year's trends report,[10] the magnitude of the 1982-83 increase was likely attributable in part to meteorological conditions that were more conducive to ozone formation in 1983. The addition of the 1984 data lends further support to this explanation because average ambient ozone levels in 1984 were 10 percent less than 1983 even though VOC emissions are estimated to have increased by 5 percent between these 2 years. A study of the Chicago area for 1977-83 developed a meteorological index for ozone potential and concluded that 1983 had more ozone conducive days than 1981 and 1982 so that the ozone increase in 1983 was reasonable.[21] This same index also showed that 1984 had fewer ozone conducive days than 1983 which would be consistent with a decrease in ozone levels between 1983 and 1984.[22] A different meteorological index was examined in an ozone trends analysis for the Los Angeles area and concluded that the ozone potential for 1982 in that area was the lowest of any year in the 1956-84 time period.[14] The difficulties of extending these meteorological explanations and indices to broader geographical areas has been discussed previously.[10] However, to provide additional insight on the ozone trend, a simplified ozone potential index was considered using meteorological information on temperature, wind speed, and cloud cover. These data were obtained from the National Climatic Data Center for ten different cities: New York, Philadelphia, Atlanta, Cincinnati, St. Louis, Houston, Minneapolis, Denver, Los Angeles, and Portland. Ambient ozone data from nearby monitoring sites were used to determine site-specific cut-off values for the meteorological variables.[23] For each site, individual yearly index values were normalized by dividing by the 1979-84 average for that site and then the average for the year was computed for the monitors in that area. These individual city results could then be averaged to obtain a national composite ozone potential index. In view of the oversimplifications involved, this approach should be viewed with caution but, even though the index is likely to be inadequate for an individual city, the relative change in the overall index from year to year may be useful. In this case, the index is consistent with the explanation that 1983 was more conducive for ozone formation than either 1982 or 1984. Again, because of the simplifications involved, these results should be viewed as only suggestive rather than definitive but they do agree with the hypothesis that 1983 ozone levels were higher than 1982 and 1984 in part because of the differences in meteorological conditions for those years.

Total VOC emissions are estimated to have decreased by 5 percent between 1980 and 1984, as shown in Table 3-5, with a 12 percent decrease for transportation sources.[7] Between 1983 and 1984, total VOC emissions are estimated to have increased by 5 percent primarily due to an increase in the industrial process portion. The major component affecting this estimated increase was related to organic solvents.

Figure 3-36 displays the composite average second highest daily maximum ozone value by EPA Region for the years 1982-84. This graph illustrates how widespread the low-high-low pattern was with 1983 being the highest of the 3-year period. This pattern occurred in nine of the ten Regions with only the Pacific Northwest departing from this pattern.

Because of the complexity of recent ozone trends, it is probably useful to briefly summarize the patterns. Just as the 1982-83 increase in ozone levels was thought to be partly attributable to meteorological conditions in 1983 being more favorable for ozone formation, the 1983-84 decrease should also be viewed as being in part a result of the 1983 meteorological conditions. Total VOC emissions are estimated to have decreased 5 percent in the 1980's with transportation sources showing 12 percent improvement and industrial processes decreasing by 6 percent. However, industrial process emissions are estimated to have increased between 1983 and 1984. The 1983-84 improvement in ambient ozone levels is likely due in part to the year to year differences in meteorological conditions. The 1984 ambient ozone levels are very similar to the 1981-82 levels. This occurred despite an estimated national growth of almost 200 billion vehicle miles of travel between 1980 and 1984, an increase of 13 percent.[24]

3.6 TRENDS IN LEAD

Lead (Pb) gasoline additives, non-ferrous smelters, and battery plants are the most significant contributors to atmospheric lead emissions. Transportation sources alone contribute about 80 percent of the annual emissions.

Prior to promulgation of the lead standard in October 1978,[25] two air pollution control programs were implemented by EPA that have resulted in lower ambient lead levels. First, regulations were issued in the early 1970's which required the lead content of all gasoline to be gradually reduced over a period of many years. Most recently the lead content of leaded gasoline was reduced from an average of 1.0 grams/gallon to 0.5 grams/gallon on July 1, 1985 and still further to 0.1 grams/gallon on January 1, 1986. Second, as part of EPA's overall automotive emission control program, unleaded gasoline was introduced in 1975 for use in automobiles equipped with catalytic control devices which reduced emissions of carbon monoxide, hydrocarbons and nitrogen oxides. Additionally, lead emissions from stationary sources have been substantially reduced by control programs oriented toward attainment of the TSP and lead ambient standards. The overall effect of these three control programs has been a major reduction in the amount of lead in the ambient air.

3.6.1 Long-term Lead Trends: 1975-84

Previous trend analyses of ambient Pb data[26,27] were based almost exclusively on National Air Surveillance Network (NASN) sites. These sites were established in the 1960's to monitor ambient air quality levels of TSP and associated trace metals, including lead. The sites were predominantly located in the central business districts of larger American cities. In October 1980, new ambient Pb monitoring regulations were promulgated.[29] The siting criteria in the regulations resulted in the elimination of many of the old historic TSP monitoring sites as being unsuitable sites for the measurement of ambient Pb concentrations.

As with the other pollutants the trend sites that were selected had to satisfy an annual data completeness criterion of at least 8 out of 10 years of data in the 1975 to 1984 time period. A year was included as "valid" if at least 3 of the 4 quarterly averages were available. A total of only 36 urban-oriented sites, representing just eight states, met the data completeness criteria. Only six of these sites were NAMS sites, thereby, making a NAMS trend determination impossible. Twenty-seven of the trend sites were located in the States of Arizona, Pennsylvania and Texas. A total of 147 sites satisfied a trend criteria for the 1980-84 period, which required 4 out of 5 years in the 1980 to 1984 time period.

The mean of the composite maximum quarterly averages and their respective 95 percent confidence intervals are shown in Figure 3-37 for both 36 urban sites (1975-1984) and 147 sites (1980-1984). There was a 70 percent overall (1975-84) decrease. The confidence intervals indicate that the 1975-78 averages are significantly different from the 1980-84 averages. The decrease was 38 and 45 percent in the mean (1980-84) respectively for the 36 sites or the larger sample of 147 sites. For

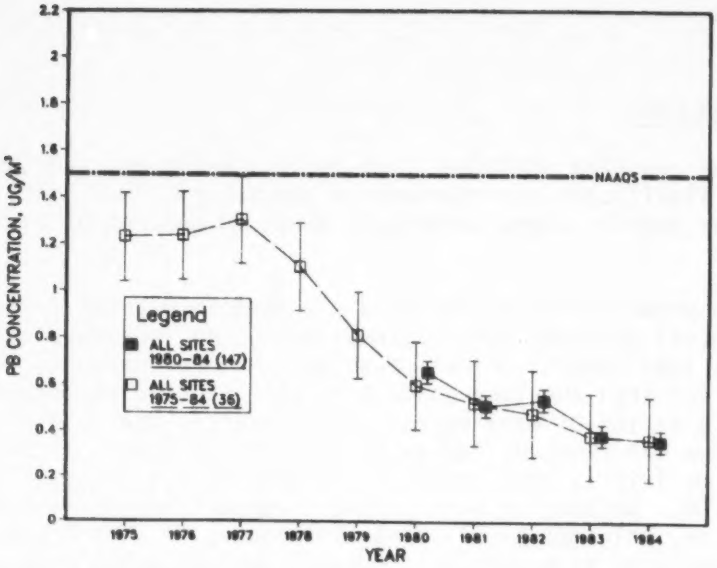


Figure 3-37. National trend in the composite average of the maximum quarterly average lead concentration at 36 sites (1975-1984) and 147 sites (1980-1984) with 95 percent confidence intervals.

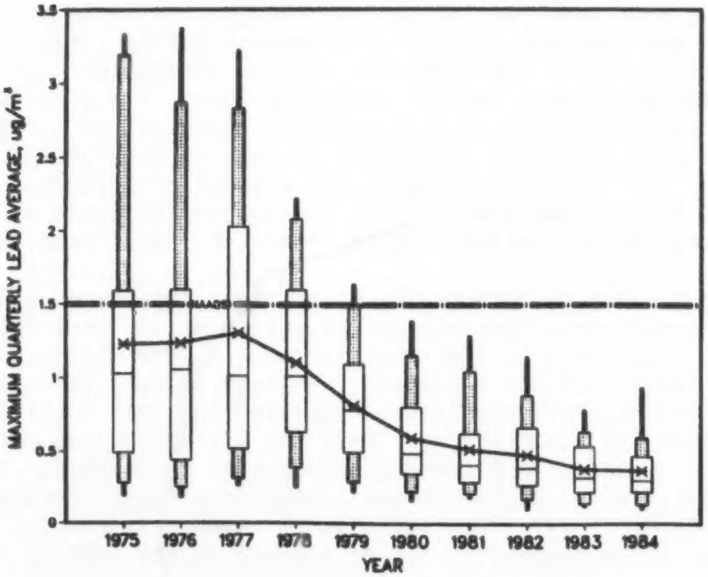


Figure 3-38. Boxplot comparisons of trends in maximum quarterly average lead concentrations at 36 sites, 1975-1984.

the larger sample of trend sites covering the 1980-84 period, the 1983 and 84 means are statistically different from the 1980-82 means. Thus, the downward trend in ambient Pb levels is continuing. The box plots are shown in Figure 3-38 for the 1975-84 period. All percentiles basically show the same overall downward pattern as the mean.

In last year's report[10], a larger sample of 61 urban-oriented sites qualified as trend sites for the 1975-83 time period. The loss of 25 sites qualifying to describe the 10-year (1975-84) trend was due to incomplete or missing data in 1984. Fourteen of the 25 sites came from data contributed by the State of Texas which appears to be discontinuing many of their long-term Pb sites. Because of the small number of 1975-84 trend sites relative to the 1980-84 trend sites more importance should be given to the 5-year (1980-84) trend.

The 1975-84 trends in total lead emissions based on information from the National Emissions Data System[7] is shown in Figure 3-39. Table 3-6 summarizes the lead emissions data as well. The drop (1975-84) in lead emissions was 72 percent. This compares with a 70 percent decrease (1975-84) in ambient lead noted above. The drop in lead consumption since 1975 was brought about because of the increased use of unleaded gasoline in catalyst equipped cars and the reduced lead content in other gasoline. In 1984 unleaded gasoline sales represented about 60 percent of the total gasoline sales. Although the good agreement between the trend in lead consumption, emissions, and ambient levels may be more fortuitous than real due to the imbalanced national sample of trend sites, it does show that ambient urban Pb levels are responding to the drop in lead emissions.

3.6.2 Recent Lead Trends: 1980-84

Ambient Pb trends as noted above were also studied over the shorter term period 1980-84 (Figure 3-40). A total of 147 urban sites from 23 states met the minimum data requirement of at least 4 out of the 5 years of data. This larger and more representative set of sites showed an improvement of 45 percent over this time period. This corresponds to reductions in lead emissions of 43 percent. Even this larger group of sites was disproportionately weighted by sites in California and Pennsylvania. These states accounted for 52 percent of the 147 sites represented. Ambient lead levels have decreased in each of these states. Also shown is Figure 3-41 is the Pb trend at the 21 NAMS and for the entire sample of 147 trend sites. The short-term Pb trend at 21 NAMS sites is very similar to the trend for all sites although the Pb levels are higher, because NAMS sites are located only in the larger cities and in areas of maximum Pb emissions. Interestingly, the decrease in ambient lead levels is so pronounced, that the 21 NAMS, while few in number, show statistically significant decreases with the 1983 and 1984 composite averages significantly less than the 1980 composite average.

Table 3-6. National Lead Emission Estimates, 1975-1984

(million metric tons/year)

Source Category	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Transportation	122.6	132.4	124.2	112.4	94.6	59.4	46.4	46.9	40.7	34.7
Fuel Combustion	9.3	8.3	7.2	6.1	4.9	4.0	2.8	1.7	0.6	0.5
Industrial Process	10.3	8.1	5.7	5.4	5.2	3.6	3.0	2.7	2.4	2.3
Solid Waste	4.8	4.3	4.1	4.0	4.0	3.7	3.7	3.1	2.6	2.6
Total	147.0	153.1	141.2	127.9	108.7	70.7	55.9	54.4	46.3	40.1

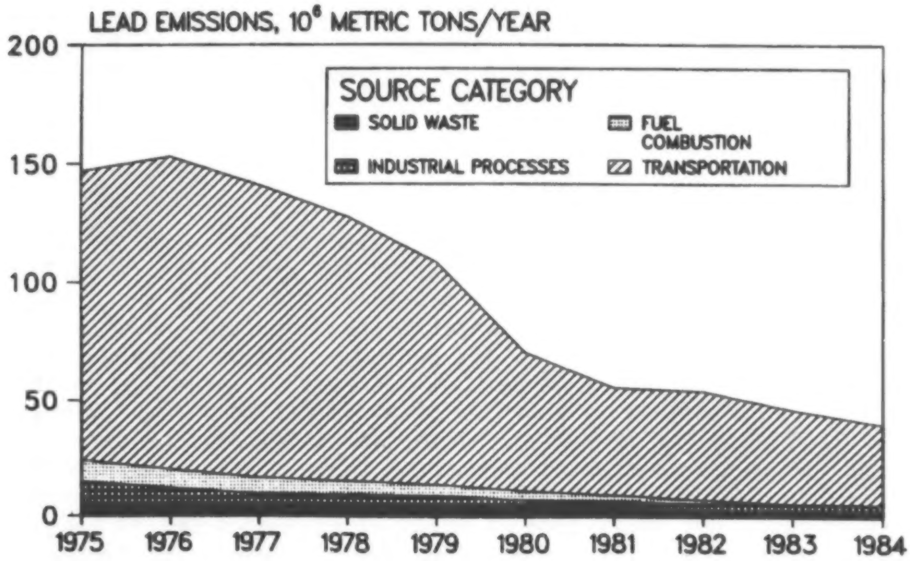


Figure 3-39. National trend in lead emissions, 1975-1984.

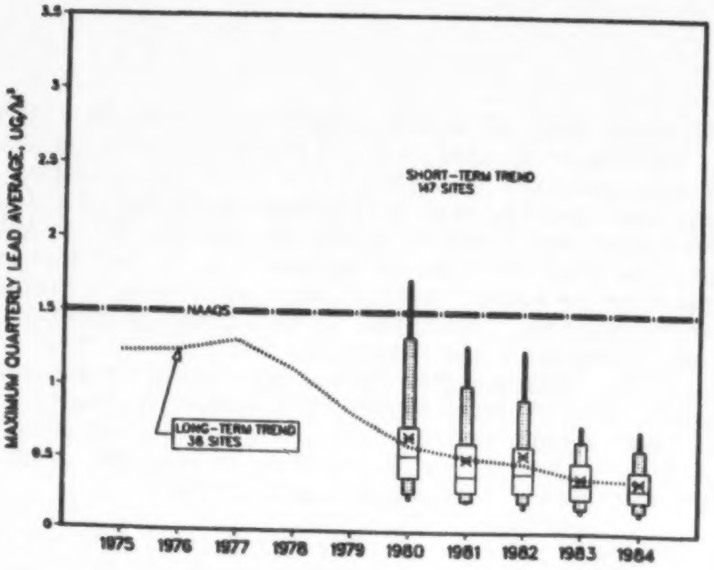


Figure 3-40. Comparison of long-term and recent trends in maximum quarterly average lead concentrations.

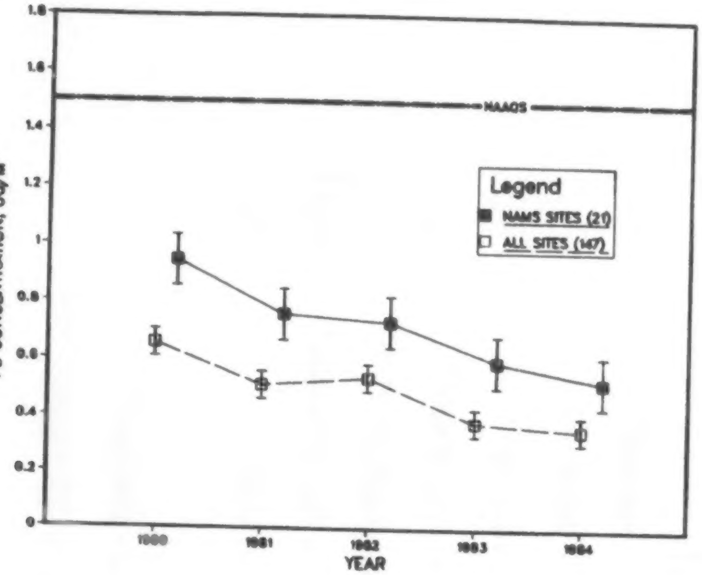


Figure 3-41. National trend in the composite average of the maximum quarterly average lead concentration at both NAMS and all sites with 95 percent confidence intervals, 1980-1984.

Figure 3-42 shows 1982, 83 and 84 composite average Pb concentrations by EPA region. The number of sites vary dramatically from no sites in Region VIII and only one site in Region II to 58 sites in Region IX. To a large extent then the regional differences noted results from this disparity in the number and types of sites represented and do not represent true differences. Only in the case of Regions III, V, and IX can somewhat reasonable comparisons be made. The influence of a single lead point source at a site in St. Paul, Minnesota in 1982 greatly inflates this composite average in Region V and results in the dramatic improvement in subsequent years. The 1983 and 1984 levels are fairly comparable between these three regions with slightly higher Pb averages in Region IX followed by Region V and lower levels in Region III. This ordering seems reasonable due to the fact that Regions IX and V are heavily weighted respectively by sites in the larger cities of Los Angeles and Chicago.

The sites in Region III represent more of a cross section of the entire region, that is smaller cities which account for its lower Pb levels. Another point to note from this figure is that most regions show the expected improvement in Pb concentrations over the 1982-84 time period. For the three regions with 10 or more sites there is improvement in each of the 3 years with the exception of Region III where the 1983 and 1984 means are the same.

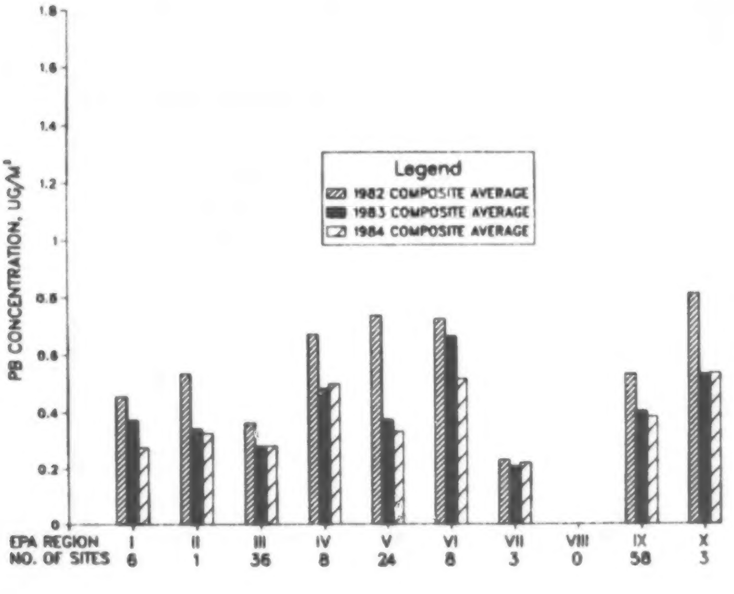


Figure 3-42. Regional comparison of the 1982, 1983, 1984 composite average of the maximum quarterly average lead concentration.

3.7 REFERENCES

1. Tukey, J. W., Exploratory Data Analysis. Addison-Wesley Publishing Company, Reading, MA, 1977.

2. Winer, B. J., Statistical Principles in Experimental Design. McGraw-Hill, NY, 1971.

3. Johnson, N. L., and S. Kotz, Discrete Distributions. Wiley, NY, 1969,

4. Miller, R. G., Jr., Simultaneous Statistical Inference. Springer-Veriag, NY, 1981.

5. Pollack, A. K., W. F. Hunt, Jr., and T. C. Curran, "Analysis of Variance Applied to National Ozone Air Quality Trends," presented at the 77th Annual Meeting of the Air Pollution Control Association, San Francisco, CA, June 1984.

6. A. Pollack and W. Hunt, "Analysis of Trends and Variability in Extreme and Annual Average Sulfur Dioxide Concentrations," Transactgions of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. 1985.

7. National Air Pollutant Emission Estimates, 1940-1984. U. S. Environmental Protection Agency. Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA-450/4-85-014, January 1986.

8. Frank, N. H., "Nationwide Trends in Total Suspended Particulate Matter and Associated Changes in the Measurement Process," Transactions of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. 1985.

9. Hauser, R. T., U. S. Environmental Protection Agency, "Impact of Filter Change on TSP Trends," memorandum to R. G. Rhoads, January 11, 1984.

10. National Air Quality and Emissions Trends Report, 1983. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 450/4-84-029. April 1985.

11. Steigerwald, J., Analysis of Precipitation Variables for the Continental United States. PEI Associates, Inc., Durham, NC. Report prepared for Neil H. Frank, U. S. Environmental Protection Agency, Contract No. 68-02-3855. September 1985.

12. National Air Quality and Emissions Trends Report, 1976. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Publication No. EPA 450/1-77-022. December 1977.

13. Wijnberg, L., T. Johnson, J. Steigerwald, J. Capel and R. Paul. Analysis of Possible Causes of Decreased TSP Levels, 1981 to 1982. PEI Associates, Inc., Durham, NC. Report prepared for Neil H. Frank, U. S. Environmental Protection Agency, Contract No. 68-02-3855. July 1985.

14. Davidson, A., M. Haggan and P. Wong. Air Quality Trends in the South Coast Air Basin, 1975-1984. South Coast Air Quality Management District, El Monte, CA. August 1985.

15. National Acid Precipitation Assessment Program (NAPAP), 1980 NAPAP Data Base, Version 3.0. September 1984.

16. Pechan, E. and J. Wilson, Jr. "Estimates of 1973-1982 Annual Sulfur Oxide Emissions from Electric Utilities." J. Air Poll. Control Assoc. Vol. 34, No. 10. pp 1075-1078. September 1984.

17. Koerber, W. M., "Trends in SO_2 Emissions and Associated Release Height for Ohio River Valley Power Plants," presented at the 75th Annual Meeting of the Air Pollution Control Association, New Orleans, LA. June 1982.

18. Bergesen, C. Utility Data Institute, Inc., letter to F. William Brownell, Esq., Hunter and Williams, February 21, 1985.

19. Oppenheimer, M., C. Epstein and R. Yuhnke, "Acid Deposition, Smelter Emissions and the Linearity Issue in the Western United States." Science, Vol. 229, pp. 859-862, August 30, 1985.

20. Federal Register, Vol. 43, June 22, 1978, pp. 26971-26975.

21. Sweitzer, T. A. and D. J. Kolaz, "An Assessment of the Influence of Meteorology on the Trend of Ozone Concentrations in the Chicago Area," Transactions of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. 1985.

22. Kolaz, D., Illinois Environmental Protection Agency, personal communication with T. Curran, U. S. Environmental Protection Agency, October 15, 1985.

23. Pollack, A. and M. Moezzi. "Application of a Simple Meteorological Index of Ambient Ozone Potential to Ten Cities." Systems Applications, Inc., San Rafael, CA. December 1985.

24. Highway Statistics 1984, U. S. Department of Transportation, Federal Highway Administration, Washington, D. C. Publication No. HHP-41/10-85(3M)QE. October 1985.

25. Federal Register, Vol. 45, October 10, 1980, pp. 67564-67575.

26. Faoro, R. B. and T. B. McMullen, National Trends in Trace Metals Ambient Air, 1965-1974. U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Research Triangle Park, NC. Publication No. EPA-450/1-77-003. February 1977.

27. W. Hunt, "Experimental Design in Air Quality Management," Andrews Memorial Technical Supplement, American Society for Quality Control, 1984.

4. AIR QUALITY LEVELS IN STANDARD METROPOLITAN STATISTICAL AREAS

The Tables in this section summarize air quality levels by Standard Metropolitan Statistical Area (SMSA) for SMSA's with populations greater than 500,000. These summaries are complemented with an analysis of the number of people living in counties in which pollutant specific primary health NAAQS(s) (Table 1-1) were exceeded by measured air quality in 1984 (Figure 1-1). Clearly, O_3 is the most pervasive air pollution problem in the United States with an estimated 79.2 million people living in counties which exceeded the O_3 standard. CO follows with 61.3 million people, TSP with 32.6 million people, NO_2 with 7.5 million people, lead with 4.7 million people and SO_2 with 1.7 million people.

In the SMSA summary tables which follow, the air quality statistics relate to pollutant-specific NAAQS. The purpose of these summaries is to provide the reader with information on how air quality varies among SMSA's and from year-to-year. The higher air quality levels measured in the SMSA are summarized for the years 1982, 1983 and 1984.

The reader is cautioned that these summaries are not sufficient in themselves to adequately rank or compare the SMSA's according to their air quality. To properly rank the air pollution severity in different SMSA(s), data on population characteristics, daily population mobility, transportation patterns, industrial composition, emission inventories, meteorological factors and, most important, the spatial representativeness of the monitoring sites would also be needed.

The same annual data completeness criterion used in the air quality trends data base was used here for the calculation of annual means. (See Section 2.1). If some data have been collected at one or more sites, but none of these sites meet the annual data completeness criteria, then the reader will be advised that there are insufficient data to calculate the annual mean.

With respect to the summary statistics for air quality levels with averaging times less than or equal to 24-hours, measured with continuous monitoring instruments, a footnote will be placed next to the level if the volume of annual data is less than 4380 hours for CO, less than 183 days for SO_2 or less than 50 percent of the days during the ozone season for ozone, which varies by State.[1] For example, in California the ozone season is defined as 12 months, January through December, while in New Jersey it is defined as 7 months, April through October.

4.1 SUMMARY STATISTICS

In the following SMSA summaries, the air quality levels reported are the highest levels measured within the SMSA(s). All available sites in an SMSA are used in these summaries. In the case of O_3, the problem as stated earlier is pervasive and the high values associated with the pollutant can reflect a large part of the SMSA. In contrast, the high CO values are generally highly localized and reflect downtown areas with heavy traffic.

Table 4-1. Air Quality Summary Statistics and Their Associated National Ambient Air Quality Standards (NAAQS)

POLLUTANT	STATISTICS	PRIMARY NAAQS
Total Suspended Particulate	annual geometric mean	75 ug/m^3
Sulfur Dioxide	annual arithmetic mean	0.03 ppm
	second highest 24-hour average	0.14 ppm
Carbon Monoxide	second highest nonoverlapping 8-hour average	9 ppm
Nitrogen Dioxide	annual arithmetic mean	0.053 ppm
Ozone	second highest daily maximum 1-hour average	0.12 ppm
Lead	maximum quarterly average	1.5 ug/m^3

ug/m^3 = micrograms per cubic meter
ppm = parts per million

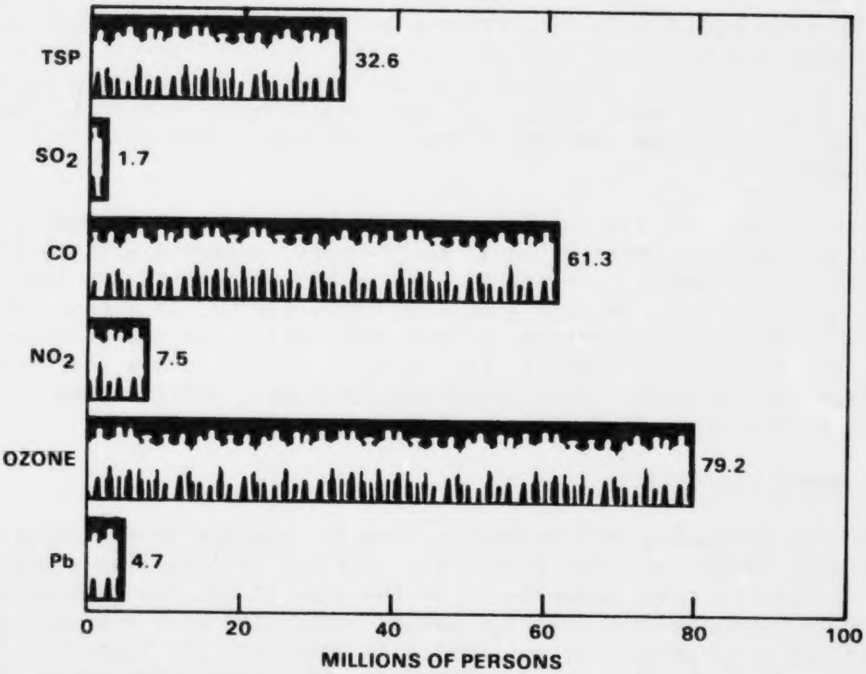


Figure 4-1. Number of persons living in counties with air quality levels above the National Ambient Air Quality Standards in 1984 (Based on 1980 population data)

The scale of measurement for the pollutants - TSP, SO_2 and NO_2 - fall somewhere in between. Finally, while lead measurements generally reflect lead concentrations near roadways in the SMSA, if the monitor is located near a source of lead emissions it can produce readings substantially higher. Such is the case in several SMSAs. If the lead monitor is located near a source it will be footnoted accordingly in Table 4-8.

The pollutant-specific statistics reported are summarized in Table 4-1, along with their associated primary NAAQS concentrations. For example, if an SMSA has three ozone monitors in 1982 with second highest daily hourly maxima of .15 ppm, .14 ppm and .12 ppm, the highest of these, .15 ppm, would be reported for that SMSA for 1982.

In the case of Pb, the quarterly average is based either on as many as 90 24-hour measurements or one or more chemical composite measurements.* Most of the maximum quarterly Pb averages are based on multiple 24-hour measurements. If the maximum quarterly average is based on a chemical composite, it is footnoted accordingly.

4.2 AIR QUALITY SMSA COMPARISONS

In each of the following SMSA air quality summaries, the SMSA's are grouped according to population starting with the largest SMSA - New York, NY-NJ and continuing to the smallest SMSA with a population in excess of 500,000, Long Branch - Asbury Park, NJ. The population groupings and the number of SMSA's contained within each are as follows: 16 SMSA's have populations in excess of 2 million, 23 SMSA's have populations between 1 and 2 million and 41 SMSA's have populations between 0.5 and 1 million. The population statistics are based on the 1980 census.

Air quality maps of the United States are introduced to show at a glance how air quality varies among the 80 SMSA's. Figures 4-1 through 4-7 appear just before the appropriate table summarizing the same air pollution specific statistic. In each map, a spike is plotted at the city location on the map surface. This represents the highest pollutant concentration, recorded in 1984, corresponding to the appropriate air quality standard. Each spike is also projected onto a backdrop facilitating comparison with the level of the standard. This also provides an east-west profile of concentration variability throughout the country.

The air quality summary statistics are summarized in the following figures and tables:

Figure 4-2. United States Map of the Highest Annual Geometric Mean Suspended Particulate Concentration by SMSA. The map for particulate matter displays the maximum annual geometric mean TSP concentration in 1984 for large metropolitan areas. The highest concentrations are generally found

*A chemical composite measurement can be either a measurement for an entire month or an entire quarter.

in the industrial Midwest and arid areas of the West. The east-west profile shows that levels above the current standard of 75 ug/m^3 can be found throughout the Nation.

Table 4-2. Highest Annual Geometric Mean Suspended Particulate Concentration by SMSA, 1981-83.

Figure 4-3. United States Map of the Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by SMSA, 1983. The map for sulfur dioxide shows maximum annual mean concentrations in 1984. Among these large metropolitan areas, the higher concentrations are found in the heavily populated Midwest and Northeast. The peak SO_2 mean concentration occurs in Pittsburgh, PA at an individual site near a large steel complex. All other urban areas have lower ambient air quality concentrations, well within the current annual standard of 80 ug/m^3 (.03 ppm). Because this map only represents areas with population greater than one half million, it does not reflect air quality in the vicinity of smelters or large power plants in rural areas.

Table 4-3. Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by SMSA, 1981-83.

Figure 4-4. United States Map of the Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by SMSA, 1983. The map for sulfur dioxide shows the highest second highest maximum 24-hour average sulfur dioxide concentration by SMSA in 1984. The highest concentration occurs in Pittsburgh, PA at an individual site near a large steel company. This concentration exceeds the level of the short-term standard. All other urban areas have lower ambient concentrations below the 24-hour NAAQS of 0.14 parts per million.

Table 4-4. Highest Second Maximum 24-hour Average Sulfur Dioxide Concentration by SMSA, 1981-83.

Figure 4-5. United States Map of the Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by SMSA, 1983. The map for carbon monoxide shows peak metropolitan concentrations in terms of the second highest annual 8-hour value recorded in 1984. The east-west profile indicate that many of these urban areas in all geographic regions have air quality at or exceeding the 9 ppm level of the standard.

Table 4-5. Highest Second Maximum Nonoverlapping 8-hour Average Carbon Monoxide Concentration by SMSA, 1981-83.

Figure 4-6. United States Map of the Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by SMSA, 1983. The map for nitrogen dioxide displays the maximum annual mean measured in the Nation's largest metropolitan areas during 1984. Los Angeles, California is the only area in the country exceeding the air quality standard of .053 ppm.

Table 4-6. Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by SMSA, 1981-83.

Figure 4-7. United States Map of the Highest Second Daily Maximum 1-hour Average Ozone Concentrations by SMSA, 1983. The ozone map shows the second highest daily maximum concentration in the 80 largest metropolitan areas. As shown, slightly over half of these areas did not meet the 0.12 ppm standard in 1984. The highest concentrations are observed in Southern California, but high levels also persist in the Texas Gulf Coast, northeast corridor, and other heavily populated regions.

Table 4-7. Highest Second Daily Maximum 1-hour Average Ozone Concentration by SMSA, 1981-83.

Figure 4-8. United States Map of the Highest Maximum Quarterly Average Lead Concentration by SMSA, 1983. The map for lead displays maximum quarterly average concentrations in the Nation's largest metropolitan areas. The highest concentrations are found throughout the country in cities containing nonferrous smelters or other point sources of lead. Because of the switch to unleaded gasoline, other areas, primarily affected by automotive lead emissions, show levels below the current standard of 1.5 ug/m^3.

Table 4-8. Highest Maximum Quarterly Average Lead Concentration by SMSA, 1981-83.

The air quality summaries follow:

4.3 REFERENCES

1. Rhoads, Richard G., U. S. Environmental Protection Agency, memorandum to Director of the Environmental Services Divisions and Air and Waste Management Divisions, EPA Regions I through X, 15 December 1982.

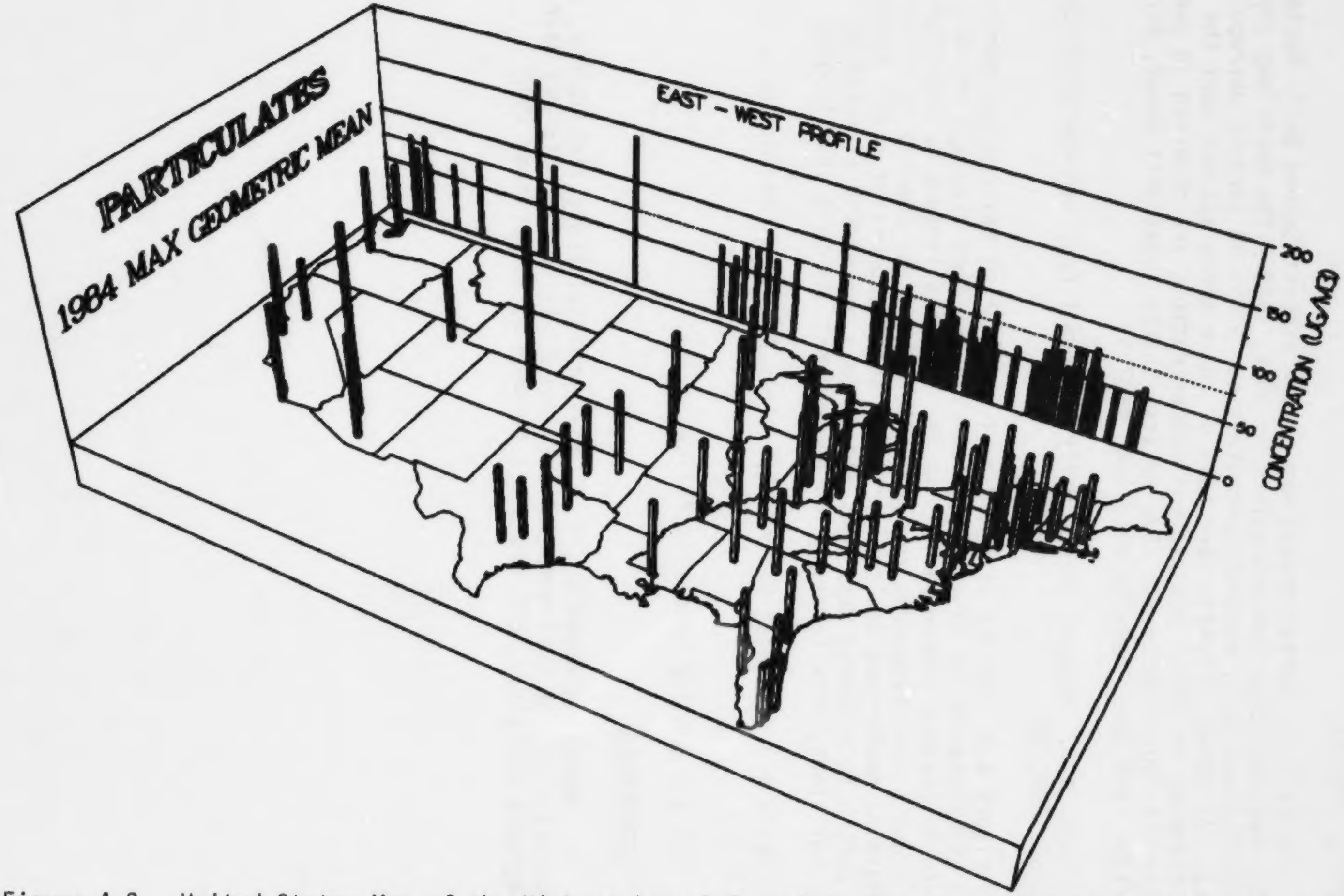

PARTICULATES
1984 MAX GEOMETRIC MEAN
EAST - WEST PROFILE
200
150
100
50
0
CONCENTRATION (UG/M3)

Figure 4-2. United States Map of the Highest Annual Geometric Mean Suspended Particulate Concentration by SMSA, 1984.

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	59	59	64
LOS ANGELES-LONG BEACH, CA	87	86	IN
CHICAGO, IL	86	93	85
PHILADELPHIA, PA-NJ	68	68	73
DETROIT, MI	112	101	106
SAN FRANCISCO-OAKLAND, CA	57	55	59
WASHINGTON, DC-MD-VA	53	59	64
DALLAS-FORT WORTH, TX	81	70	74
HOUSTON, TX	138	100	94
BOSTON, MA	71	69	58
NASSAU-SUFFOLK, NY	54	44	49
ST. LOUIS, MO-IL	134	134	119
PITTSBURGH, PA	65	77	83

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	72	76	88
MINNEAPOLIS-ST. PAUL, MN-WI	73	72	75
ATLANTA, GA	63	60	72
TOTAL SMSA'S > 2 MILLION : 16			

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	72	73	73
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	84	83	IN
CLEVELAND, OH	101	96	116
SAN DIEGO, CA	76	70	71
MIAMI, FL	48	54	50
DENVER-BOULDER, CO	169	150	142
SEATTLE-EVERETT, WA	74	72	68
TAMPA-ST. PETERSBURG, FL	57	59	68
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	103	110	IN
PHOENIX, AZ	140	125	168
CINCINNATI, OH-KY-IN	78	80	70
MILWAUKEE, WI	64	65	58
KANSAS CITY, MO-KS	71	70	69

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN		
	1982	1983	1984
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	65	55	82
BUFFALO, NY	82	66	59
PORTLAND, OR-WA	88	82	80
NEW ORLEANS, LA	63	70	64
INDIANAPOLIS, IN	67	70	69
COLUMBUS, OH	68	68	72
SAN JUAN, PR	81	73	77
SAN ANTONIO, TX	100	69	66
FORT LAUDERDALE-HOLLYWOOD, FL	48	41	48
SACRAMENTO, CA	55	52	56

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	88	49	50
SALT LAKE CITY-OGDEN, UT	68	57	67
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	56	57	53
MEMPHIS, TN-AR-MS	67	78	70
LOUISVILLE, KY-IN	75	70	82
NASHVILLE-DAVIDSON, TN	59	73	69
BIRMINGHAM, AL	84	88	98
OKLAHOMA CITY, OK	86	67	60
DAYTON, OH	60	63	59
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	54	56	57
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	53	51	57
ALBANY-SCHENECTADY-TROY, NY	55	51	60
TOLEDO, OH-MI	69	70	61

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEA

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	60	59	61
JACKSONVILLE, FL	74	56	62
HARTFORD, CT	48	47	48
ORLANDO, FL	50	47	48
TULSA, OK	88	83	72
AKRON, OH	67	60	55
GARY-HAMMOND-EAST CHICAGO, IN	90	83	88
SYRACUSE, NY	68	64	68
NORTHEAST PENNSYLVANIA	50	47	55
CHARLOTTE-GASTONIA, NC	62	54	67
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	68	57	74
RICHMOND, VA	45	46	51
GRAND RAPIDS, MI	49	52	52

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALIT. PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE ONCENTRATION BY SMSA POPULATION RANGE — PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	60	58	59
WEST PALM BEACH-BOCA RATON, FL	45	43	47
OMAHA, NE-IA	64	65	74
GREENVILLE-SPARTANBURG, SC	52	53	51
JERSEY CITY, NJ	75	78	79
AUSTIN, TX	64	54	51
YOUNGSTOWN-WARREN, OH	84	75	64
TUCSON, AZ	93	105	92
RALEIGH-DURHAM, NC	45	46	48
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	51	49	49
OXNARD-SIMI VALLEY-VENTURA, CA	63	58	63
WILMINGTON, DE-NJ-MD	53	68	46
FLINT, MI	51	57	51

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

TABLE 4-2

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SUSPENDED PARTICULATE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SUSPENDED PARTICULATE CONCENTRATION (UG/M3) HIGHEST ANNUAL GEOMETRIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	97	83	ND
LONG BRANCH-ASBURY PARK, NJ	45	45	45

TOTAL SMSA'S .5 - 1 MILLION : 41

NOTE: THE ANNUAL GEOMETRIC MEAN IS CALCULATED IF THE DATA COLLECTED SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL GEOMETRIC MEAN

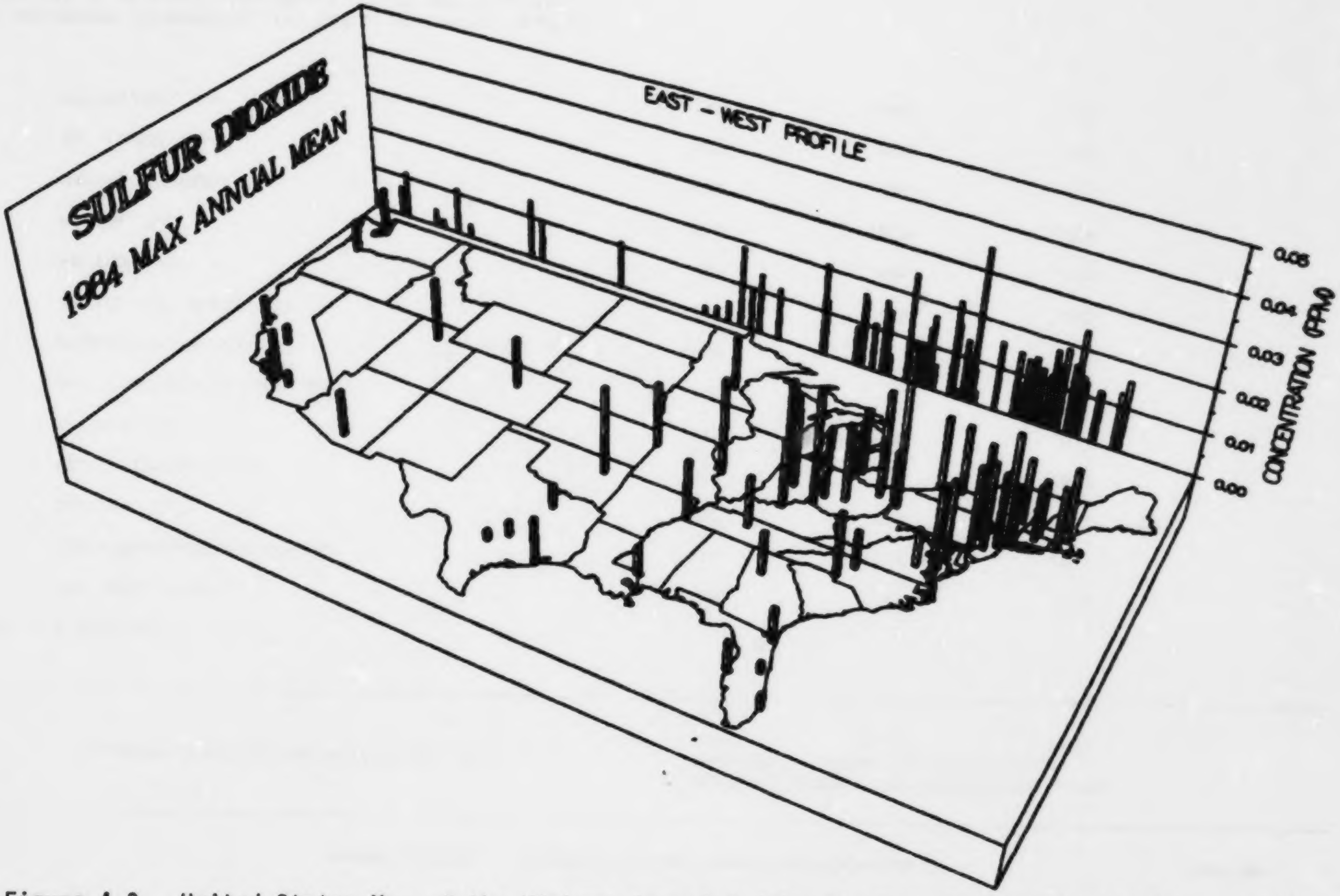

SULFUR DIOXIDE
1984 MAX ANNUAL MEAN
EAST - WEST PROFILE
CONCENTRATION (PPM)
0.05
0.04
0.03
0.02
0.01
0.00

Figure 4-3. United States Map of the Highest Annual Arithmetic Mean Sulfur Dioxide Concentration by SMSA, 1984.

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE   CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN		
	1982	1983	1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.025	.024	.024
LOS ANGELES-LONG BEACH, CA	.011	.010	.011
CHICAGO, IL	.012	.014	.017
PHILADELPHIA, PA-NJ	.020	.016	.019
DETROIT, MI	.018	.015	.014
SAN FRANCISCO-OAKLAND, CA	.002	.003	.006
WASHINGTON, DC-MD-VA	.018	.013	.014
DALLAS-FORT WORTH, TX	.007	.005	.005
HOUSTON, TX	.009	.008	.010
BOSTON, MA	.018	.019	.016
NASSAU-SUFFOLK, NY	.012	.011	.013
ST. LOUIS, MO-IL	.020	.021	.021
PITTSBURGH, PA	.046	.043	.035

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.020	.016	.015
MINNEAPOLIS-ST. PAUL, MN-WI	.018	.011	.012
ATLANTA, GA	IN	.010	.009

TOTAL SMSA'S > 2 MILLION : 16

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.017	.014	.015
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.006	.006	.007
CLEVELAND, OH	.019	.019	.022
SAN DIEGO, CA	.007	.004	IN
MIAMI, FL	.003	.002	IN
DENVER-BOULDER, CO	.011	.013	.011
SEATTLE-EVERETT, WA	.015	.013	.011
TAMPA-ST. PETERSBURG, FL	.009	.007	.006
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.007	.003	.003
PHOENIX, AZ	IN	.004	IN
CINCINNATI, OH-KY-IN	.015	.014	.025
MILWAUKEE, WI	.010	.010	.009
KANSAS CITY, MO-KS	.014	.011	.014

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	ND	ND	ND
BUFFALO, NY	.017	.016	.016
PORTLAND, OR-WA	.009	.007	.007
NEW ORLEANS, LA	.004	.007	.006
INDIANAPOLIS, IN	.018	.016	.017
COLUMBUS, OH	.017	.015	.017
SAN JUAN, PR	.008	ND	ND
SAN ANTONIO, TX	.003	.004	.002
FORT LAUDERDALE-HOLLYWOOD, FL	.001 B	IN	ND
SACRAMENTO, CA	.002	.002	IN

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
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IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.014	.012	.015
SALT LAKE CITY-OGDEN, UT	.026	.016	.014
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.016	.011	.013
MEMPHIS, TN-AR-MS	.011	.008	.013
LOUISVILLE, KY-IN	.016	.014	.015
NASHVILLE-DAVIDSON, TN	.013	.011	.011
BIRMINGHAM, AL	IN	IN	ND
OKLAHOMA CITY, OK	.001	IN	IN
DAYTON, OH	.008	.009	.010
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.005 B	.008	.008
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.011	.011	.010
ALBANY-SCHENECTADY-TROY, NY	.018	.016	.014
TOLEDO, OH-MI	.012	.010	.010

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

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B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.005 B	.003	.006
JACKSONVILLE, FL	.007	.008	.007
HARTFORD, CT	.014	.012	.012
ORLANDO, FL	.006	.002	.002
TULSA, OK	.008	.009	.019
AKRON, OH	.019	.016	.017
GARY-HAMMOND-EAST CHICAGO, IN	.018	.015	.016
SYRACUSE, NY	.010	.010	.013
NORTHEAST PENNSYLVANIA	.013	.011	.012
CHARLOTTE-GASTONIA, NC	.011	.009	.014
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.014	.013	.015
RICHMOND, VA	.008	.008	.008
GRAND RAPIDS, MI	.008	.006	.005

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE   CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.014	.013	.016
WEST PALM BEACH-BOCA RATON, FL	.003	.001	.003
OMAHA, NE-IA	.004	IN	.003
GREENVILLE-SPARTANBURG, SC	.006	.004	IN
JERSEY CITY, NJ	.015	.015	.016
AUSTIN, TX	.006	.009	.003
YOUNGSTOWN-WARREN, OH	.016	.011	.011
TUCSON, AZ	.004	.003	.010
RALEIGH-DURHAM, NC	.002 B	ND	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.012	.011	.012
OXNARD-SIMI VALLEY-VENTURA, CA	.003	.002	.002
WILMINGTON, DE-NJ-MD	.010	.018	.018
FLINT, MI	.016	.014	.008

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF 'IR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPUL TION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.004	.006	.004
LONG BRANCH-ASBURY PARK, NJ	.007	.010	ND

TOTAL SMSA'S .5 - 1 MILLION : 41

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

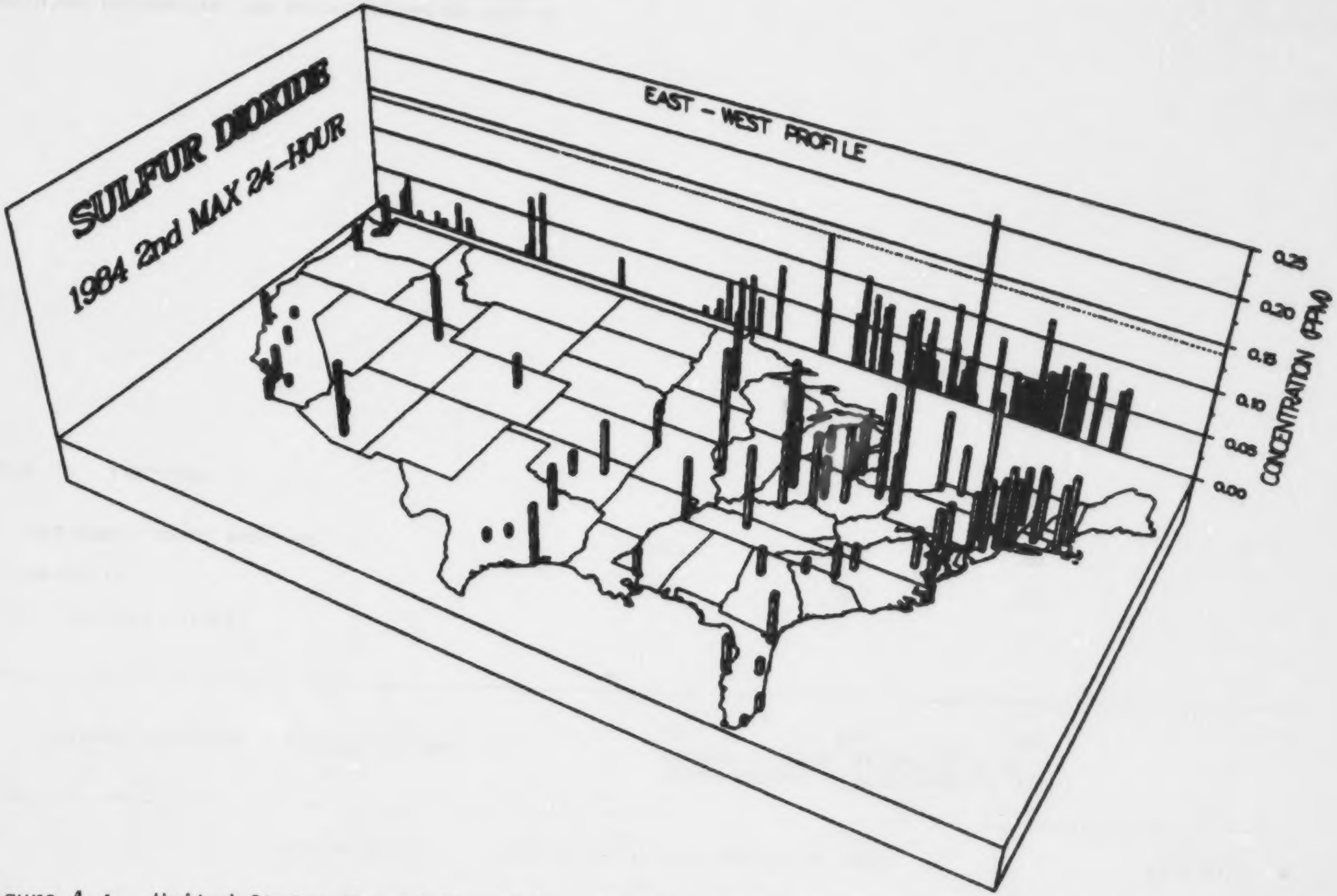

SULFUR DIOXIDE
1984 2nd MAX 24-HOUR
EAST - WEST PROFILE
0.25
0.20
0.15
0.10
0.05
0.00
CONCENTRATION (PPM)

Figure 4-4. United States Map of the Highest Second Maximum 24-Hour Average Sulfur Dioxide Concentration by SMSA, 1984.

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE   CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.079	.093	.084
LOS ANGELES-LONG BEACH, CA	.032	.037	.035
CHICAGO, IL	.056	.048	.089
PHILADELPHIA, PA-NJ	.065	.056	.076
DETROIT, MI	.069	.061	.063
SAN FRANCISCO-OAKLAND, CA	.011	.025	.033
WASHINGTON, DC-MD-VA	.069 *	.065	.045
DALLAS-FORT WORTH, TX	.017	.048	.047
HOUSTON, TX	.071	.040 *	.065
BOSTON, MA	.061	.054	.073
NASSAU-SUFFOLK, NY	.056	.044	.075
ST. LOUIS, MO-IL	.479 **	.123	.136
PITTSBURGH, PA	.212	.197	.210

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT
** THIS VALUE HAS BEEN REVIEWED AND VERIFIED BY EPA'S REGIONAL OFFICE.
IT RESULTS FROM SO2 EMISSIONS FROM 2 POWER PLANTS NEAR THE MONITORING SITE.

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE   CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.071 *	.060	.050
MINNEAPOLIS-ST. PAUL, MN-WI	.225	.089	.087
ATLANTA, GA	.038 *	.052	.028

TOTAL SMSA'S > 2 MILLION : 16

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.067	.052	.061
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.015	.015	.016
CLEVELAND, OH	.097 *	.091 *	.106
SAN DIEGO, CA	.030	.018	.021 *
MIAMI, FL	.009	.008	.006 *
DENVER-BOULDER, CO	.039	.041	.035
SEATTLE-EVERETT, WA	.051	.047	.045
TAMPA-ST. PETERSBURG, FL	.047	.043	.036
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.015	.012	.010
PHOENIX, AZ	.011 *	.012	.013 *
CINCINNATI, OH-KY-IN	.096	.090 *	.078
MILWAUKEE, WI	.049	.056	.060
KANSAS CITY, MO-KS	.128	.042	.042

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	ND	ND	ND
BUFFALO, NY	.070	.100	.085
PORTLAND, OR-WA	.033	.025	.027
NEW ORLEANS, LA	.020	.026	.027
INDIANAPOLIS, IN	.068	.102	.077
COLUMBUS, OH	.069	.068	.083
SAN JUAN, PR	.040	ND	ND
SAN ANTONIO, TX	.011	.011	.010
FORT LAUDERDALE-HOLLYWOOD, FL	.004 *	.011 *	ND
SACRAMENTO, CA	.008	.008	.009 *

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.055	.050	.052
SALT LAKE CITY-OGDEN, UT	.085	.089	.073
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.060	.047	.068
MEMPHIS, TN-AR-MS	.055	.045	.067
LOUISVILLE, KY-IN	.077	.079	.082
NASHVILLE-DAVIDSON, TN	.077	.056	.088
BIRMINGHAM, AL	.029 *	.069 *	ND
OKLAHOMA CITY, OK	.011 *	.020 *	.024 *
DAYTON, OH	.039	.036	.044
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.016 *	.018	.025
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.034	.036	.031
ALBANY-SCHENECTADY-TROY, NY	.068	.056	.060
TOLEDO, OH-MI	.082	.068	.038

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.045 *	.023 *	.025
JACKSONVILLE, FL	.057	.064	.052
HARTFORD, CT	.053	.054	.081
ORLANDO, FL	.034	.021	.014
TULSA, OK	.053	.044	.057
AKRON, OH	.114	.054	.062
GARY-HAMMOND-EAST CHICAGO, IN	.094	.090 *	.106
SYRACUSE, NY	.038	.056	.121
NORTHEAST PENNSYLVANIA	.055	.045	.065
CHARLOTTE-GASTONIA, NC	.043	.026	.035
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.052	.046	.064
RICHMOND, VA	.036	.029	.041
GRAND RAPIDS, MI	.025	.034	.026

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.058	.058	.075
WEST PALM BEACH-BOCA RATON, FL	.016	.009	.014
OMAHA, NE-IA	.033	.018 *	.012
GREENVILLE-SPARTANBURG, SC	.026 *	.025	.013 *
JERSEY CITY, NJ	.050	.048	.058
AUSTIN, TX	.012	.011	.010
YOUNGSTOWN-WARREN, OH	.062	.048	.052
TUCSON, AZ	.083 *	.016	.082
RALEIGH-DURHAM, NC	.004 *	ND	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.066	.063	.068
OXNARD-SIMI VALLEY-VENTURA, CA	.011	.010	.010
WILMINGTON, DE-NJ-MD	.042	.058	.062
FLINT, MI	.045	.038	.042

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

SULFUR DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	SULFUR DIOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 24-HR AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.016	.016	.016
LONG BRANCH-ASBURY PARK, NJ	.041	.036	ND
TOTAL SMSA'S .5 - 1 MILLION : 41			

NOTE: THE 24-HR AVERAGE IS CALCULATED BASED ON THE MIDNIGHT TO MIDNIGHT PERIOD.
* LESS THAN 183 DAYS OF DATA
ND = NO DATA
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

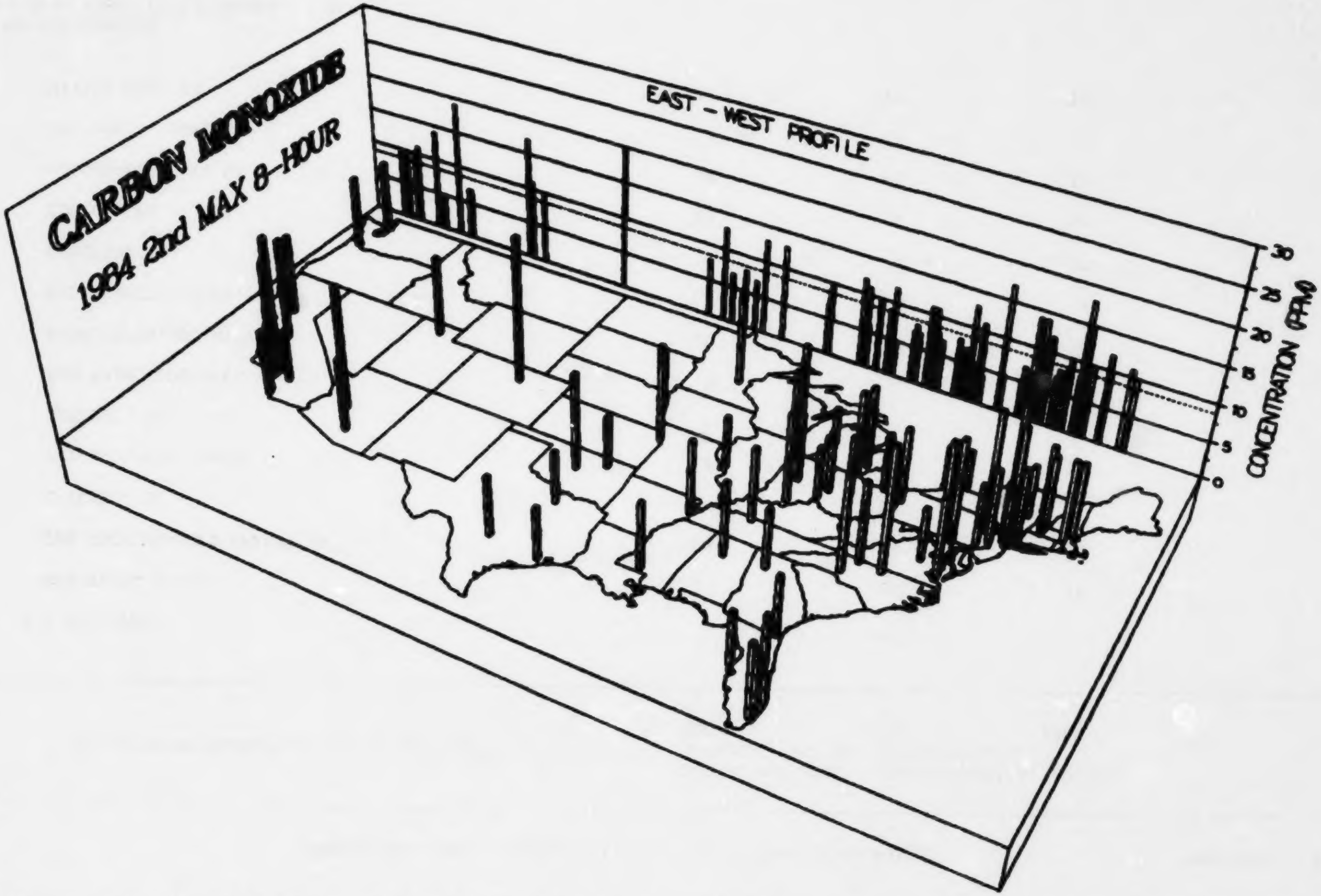


Figure 4-5. United States Map of the Highest Second Maximum Nonoverlapping 8-Hour Average Carbon Monoxide Concentration by SMSA, 1984.

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE HIGHEST 2ND MAX 1982	CONCENTRATION 8-HR N/O AVG. 1983	(PPM) 1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	13	13	15
LOS ANGELES-LONG BEACH, CA	20	19	19
CHICAGO, IL	14	13	11
PHILADELPHIA, PA-NJ	12	11	10
DETROIT, MI	10	9	11
SAN FRANCISCO-OAKLAND, CA	9	9	8
WASHINGTON, DC-MD-VA	12	13	14
DALLAS-FORT WORTH, TX	7	7	7
HOUSTON, TX	10	9 *	7
BOSTON, MA	21	14	10
NASSAU-SUFFOLK, NY	10	10	10
ST. LOUIS, MO-IL	9 *	19	7
PITTSBURGH, PA	11	13	10

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE, MD	12	13	14
MINNEAPOLIS-ST. PAUL, MN-WI	14	15	13
ATLANTA, GA	8	9	8 *

TOTAL SMSA'S > 2 MILLION : 16

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE   CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	13	11	18
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	11	11	10
CLEVELAND, OH	9	10	7
SAN DIEGO, CA	9	9	7 *
MIAMI, FL	11	11	10 *
DENVER-BOULDER, CO	17	24	20
SEATTLE-EVERETT, WA	12	11	10
TAMPA-ST. PETERSBURG, FL	7	7	7
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	8 *	9	7
PHOENIX, AZ	18	20	17
CINCINNATI, OH-KY-IN	8	7	7
MILWAUKEE, WI	9	7	12
KANSAS CITY, MO-KS	12	7	13

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	11	10	10
BUFFALO, NY	5	5	5
PORTLAND, OR-WA	10	12	10
NEW ORLEANS, LA	8	8	9
INDIANAPOLIS, IN	11	13	9
COLUMBUS, OH	9	9	8
SAN JUAN, PR	18	8	7
SAN ANTONIO, TX	8	9	8
FORT LAUDERDALE-HOLLYWOOD, FL	9	9	8
SACRAMENTO, CA	12	11	11 *

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	6	5	5
SALT LAKE CITY-OGDEN, UT	12	12 *	11
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	9	11	11
MEMPHIS, TN-AR-MS	13 *	11	10 *
LOUISVILLE, KY-IN	13	10	12
NASHVILLE-DAVIDSON, TN	12	11	10 *
BIRMINGHAM, AL	9	10	10
OKLAHOMA CITY, OK	8	9	13
DAYTON, OH	7	7	7
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	8	8	11
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	6	11	11
ALBANY-SCHENECTADY-TROY, NY	8	6	7
TOLEDO, OH-MI	7	7	11

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	7	6	6
JACKSONVILLE, FL	9	10	8
HARTFORD, CT	9	10	12
ORLANDO, FL	9	7	7
TULSA, OK	6	7	7
AKRON, OH	6	8	5
GARY-HAMMOND-EAST CHICAGO, IN	6 *	7	6
SYRACUSE, NY	5	10 *	12
NORTHEAST PENNSYLVANIA	6 *	6	7
CHARLOTTE-GASTONIA, NC	11	13	13
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	8 *	8	8
RICHMOND, VA	8	8 *	7
GRAND RAPIDS, MI	5	5	5 *

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE   CONCENTRATION BY SMSA POPULATION RANGE   PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	8	7	8
WEST PALM BEACH-BOCA RATON, FL	7	7	4
OMAHA, NE-IA	16	8	8
GREENVILLE-SPARTANBURG, SC	ND	ND	ND
JERSEY CITY, NJ	13	12	14
AUSTIN, TX	ND	ND	ND
YOUNGSTOWN-WARREN, OH	5	5	5
TUCSON, AZ	11	11	10
RALEIGH-DURHAM, NC	14 *	13	17
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	9	11	10
OXNARD-SIMI VALLEY-VENTURA, CA	6	6	5
WILMINGTON, DE-NJ-MD	7	7	8
FLINT, MI	ND	ND	ND

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

TABLE 4-5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

CARBON MONOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	CARBON MONOXIDE CONCENTRATION (PPM) HIGHEST 2ND MAX 8-HR N/O AVG. 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	13	12	14
LONG BRANCH-ASBURY PARK, NJ	8	7	8

TOTAL SMSA'S .5 - 1 MILLION : 41

NOTE: N/O NON-OVERLAPPING
* LESS THAN 4380 HOURLY VALUES OF DATA
ND = NO DATA

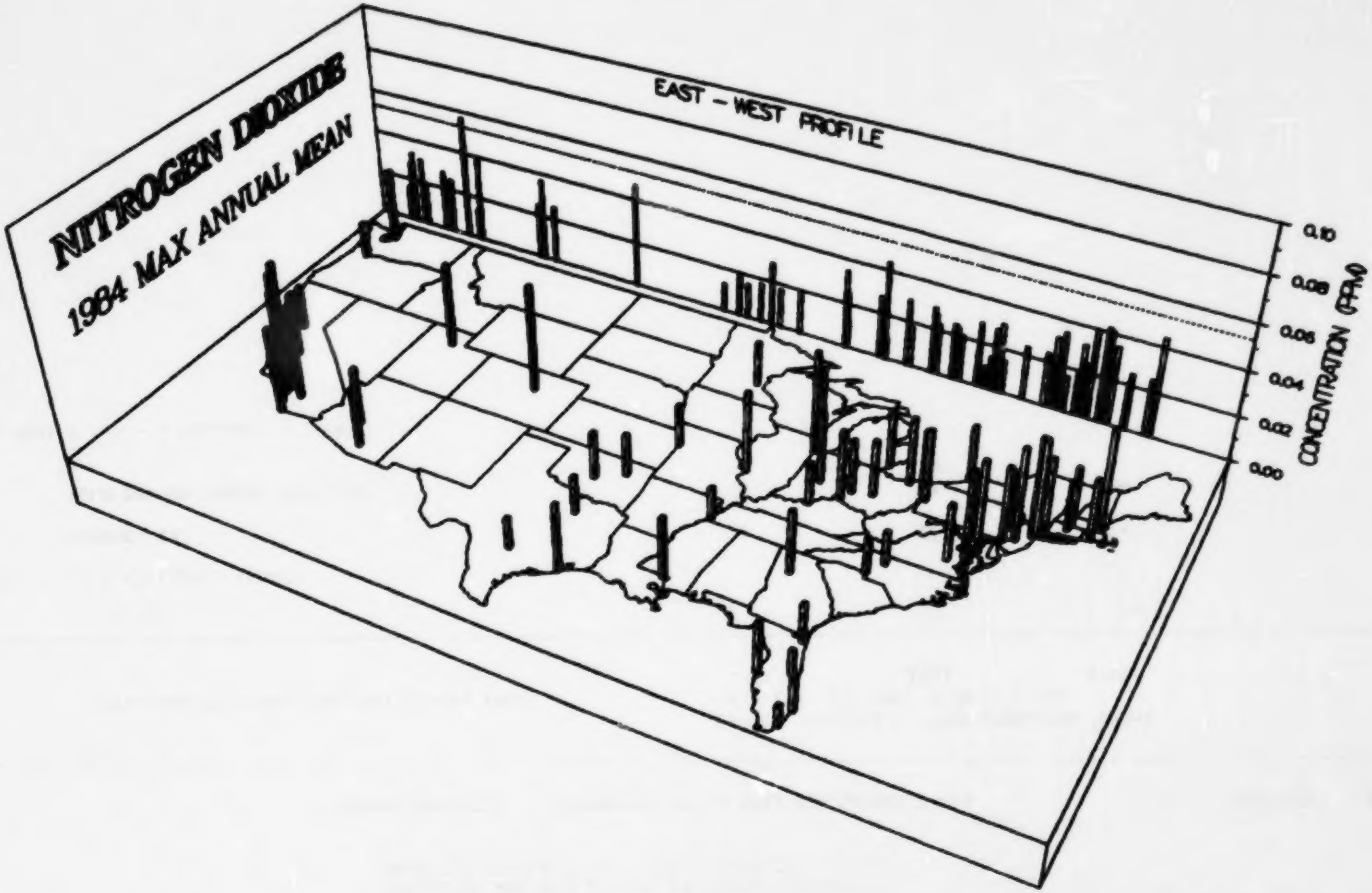

NITROGEN DIOXIDE
1984 MAX ANNUAL MEAN
EAST - WEST PROFILE
0.10
0.08
0.06
0.04
0.02
0.00
CONCENTRATION (PPM)

Figure 4-6. United States Map of the Highest Annual Arithmetic Mean Nitrogen Dioxide Concentration by SMSA, 1984.

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.036	.037	.041
LOS ANGELES-LONG BEACH, CA	.062	.059	.057
CHICAGO, IL	.052 B	.044 B	.044 B
PHILADELPHIA, PA-NJ	.039	.041	.040
DETROIT, MI	.019	.026	.025
SAN FRANCISCO-OAKLAND, CA	.027	.026	.028
WASHINGTON, DC-MD-VA	.036	.037 B	.032
DALLAS-FORT WORTH, TX	.019	.018	.016
HOUSTON, TX	.024	.027	.029
BOSTON, MA	.036	.026	.044
NASSAU-SUFFOLK, NY	.033	.034	.035
ST. LOUIS, MO-IL	.025	.026	.035
PITTSBURGH, PA	.031	.035	.031

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.032	.033	.035
MINNEAPOLIS-ST. PAUL, MN-WI	.023	.017	.019
ATLANTA, GA	.016	.025	.027
TOTAL SMSA'S > 2 MILLION : 16			

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN		
	1982	1983	1984
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.045	.043	.042
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.048	.045	.046
CLEVELAND, OH	.037 B	.028	.029
SAN DIEGO, CA	.030	.027	.014
MIAMI, FL	.023	.023	.009
DENVER-BOULDER, CO	.041	.052	.047
SEATTLE-EVERETT, WA	.048	.031	.033
TAMPA-ST. PETERSBURG, FL	.022 B	.016	.021
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.043	.042	.040
PHOENIX, AZ	.031	.018	.025
CINCINNATI, OH-KY-IN	.034	.036	.030
MILWAUKEE, WI	.028	.026	.028
KANSAS CITY, MO-KS	.018	.017	.018

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	.032	.030	.031
BUFFALO, NY	.026	.025	.024
PORTLAND, OR-WA	ND	ND	.016
NEW ORLEANS, LA	.033 B	.034 B	.026
INDIANAPOLIS, IN	.028	.028	.030
COLUMBUS, OH	.020	.023	.024
SAN JUAN, PR	ND	ND	ND
SAN ANTONIO, TX	.013	.015	.013
FORT LAUDERDALE-HOLLYWOOD, FL	.022 B	.014	ND
SACRAMENTO, CA	.018	.017	.019

TOTAL SMSA'S 1 - 2 MILLION : 23

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	ND	ND	ND
SALT LAKE CITY-OGDEN, UT	.031	.029	.037
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.025	.024	.025
MEMPHIS, TN-AR-MS	.022	.003	.014
LOUISVILLE, KY-IN	.034 B	.022	.018
NASHVILLE-DAVIDSON, TN	.053 B	ND	ND
BIRMINGHAM, AL	ND	ND	ND
OKLAHOMA CITY, OK	.018	.016	.020
DAYTON, OH	.027	.027	.023
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.023 B	.028 B	.014
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.015	.016	.016
ALBANY-SCHENECTADY-TROY, NY	ND	ND	ND
TOLEDO, OH-MI	ND	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: ..5 - 1 MILLION (CONT)			
HONOLULU, HI	.002	.002	.002
JACKSONVILLE, FL	.016	.006	.016
HARTFORD, CT	.021	.021	.021
ORLANDO, FL	.018	.011	.010
TULSA, OK	.022	.022	.018
AKRON, OH	ND	ND	ND
GARY-HAMMOND-EAST CHICAGO, IN	.009	.010	.010
SYRACUSE, NY	ND	ND	ND
NORTHEAST PENNSYLVANIA	.022	.018	.020
CHARLOTTE-GASTONIA, NC	.026 B	.024 B	.015
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.023	.022	.024
RICHMOND, VA	.024	.024	.024
GRAND RAPIDS, MI	ND	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.
ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL ·REA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.027	.027	ND
WEST PALM BEACH-BOCA RATON, FL	.009	.010	.015
OMAHA, NE-IA	ND	ND	ND
GREENVILLE-SPARTANBURG, SC	.024 B	ND	ND
JERSEY CITY, NJ	.032	.032	.028
AUSTIN, TX	ND	ND	ND
YOUNGSTOWN-WARREN, OH	.032	.025	.028
TUCSON, AZ	.036	.020	.026
RALEIGH-DURHAM, NC	.018 B	ND	ND
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.021	.025	.025
OXNARD-SIMI VALLEY-VENTURA, CA	.024	.025	.025
WILMINGTON, DE-NJ-MD	.020	.032	.032
FLINT, MI	ND	ND	ND

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

TABLE 4-6

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

NITROGEN DIOXIDE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	NITROGEN DIOXIDE CONCENTRATION (PPM) HIGHEST ANNUAL ARITHMETIC MEAN 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.027	.025	.028
LONG BRANCH-ASBURY PARK, NJ	ND	ND	ND

TOTAL SMSA'S .5 - 1 MILLION : 41

NOTE: FOR CONTINUOUS INSTRUMENTS, THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF AT LEAST 4380 HOURLY VALUES ARE COLLECTED. FOR INSTRUMENTS WHICH COLLECT ONLY ONE MEASUREMENT PER 24-HR PERIOD (BUBBLERS), THE ANNUAL ARITHMETIC MEAN IS CALCULATED IF THE DATA SATISFIES THE NADB VALIDITY CRITERIA OR AT LEAST 30 DAYS OF 24-HR DATA (50% OF THE EPA RECOMMENDED SAMPLING DAYS) HAVE BEEN COLLECTED.

ND = NO DATA
IN = INSUFFICIENT DATA TO CALCULATE THE ANNUAL ARITHMETIC MEAN
B = REPRESENTS A 24-HR BUBBLER MEASUREMENT

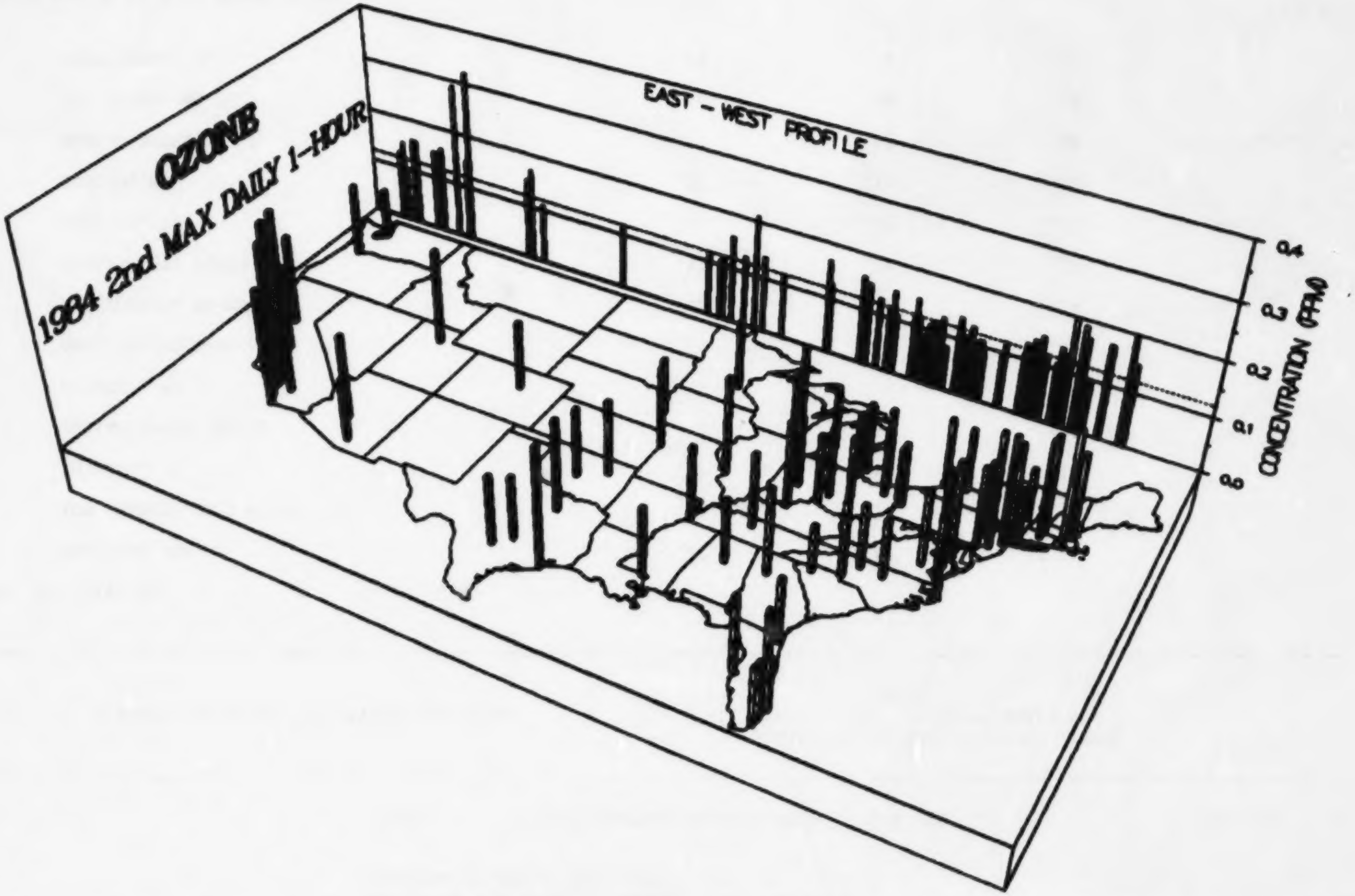

OZONE
1984 2nd MAX DAILY 1-HOUR
EAST - WEST PROFILE
0.4
0.3
0.2
0.1
0.0
CONCENTRATION (PPM)

Figure 4-7. United States Map of the Highest Second Daily Maximum 1-Hour Average Ozone Concentration by SMSA, 1984.

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1982	1-HR CONCENTRATION 2ND HIGH DAILY MAX 1983	(PPM) 1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.17	.19	.17
LOS ANGELES-LONG BEACH, CA	.35	.37	.29
CHICAGO, IL	.12	.17	.15
PHILADELPHIA, PA-NJ	.18	.19	.20
DETROIT, MI	.16	.14	.12
SAN FRANCISCO-OAKLAND, CA	.14	.17	.15
WASHINGTON, DC-MD-VA	.15	.17	.14
DALLAS-FORT WORTH, TX	.17	.16	.16
HOUSTON, TX	.21	.28	.21
BOSTON, MA	.16 *	.18	.15
NASSAU-SUFFOLK, NY	[illegible]	.17	.10
ST. LOUIS, MO-IL	.16	.18	.17
PITTSBURGH, PA	.14	.14	.11

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE

PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1982	 1983	 1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.14	.16	.15
MINNEAPOLIS-ST. PAUL, MN-WI	.10	.13	.12
ATLANTA, GA	.14	.17	.15

TOTAL SMSA'S > 2 MILLION : 16

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1982	1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX 1983	1984	
POPULATION: 1 - 2 MILLION				
NEWARK, NJ	.17	.25	.14	
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.32	.28	.26	
CLEVELAND, OH	.13	.15	.14	
SAN DIEGO, CA	.2[illegible]	.20	.15	*
MIAMI, FL	.14	.12	.10	
DENVER-BOULDER, CO	.14	.14	.12	
SEATTLE-EVERETT, WA	.09	.10	.09	
TAMPA-ST. PETERSBURG, FL	.12	.14	.13	
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.31	.34	.32	
PHOENIX, AZ	.12	.16	.15	
CINCINNATI, OH-KY-IN	.13	.15	.12	
MILWAUKEE, WI	.13	.18	.16	
KANSAS CITY, MO-KS	.10	.13	.14	

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1982		1983	1984
POPULATION: 1 - 2 MILLION (CONT)				
SAN JOSE, CA	.14		.16	.16
BUFFALO, NY	.11		.12	.12
PORTLAND, OR-WA	.12		.12	.13
NEW ORLEANS, LA	.17		.12	.12
INDIANAPOLIS, IN	.12		.14	.12
COLUMBUS, OH	.13		.12	.11
SAN JUAN, PR	.04	*	.03	.08
SAN ANTONIO, TX	.14		.12	.12
FORT LAUDERDALE-HOLLYWOOD, FL	.09		.11	.10
SACRAMENTO, CA	.13		.15	.16

TOTAL SMSA'S 1 - 2 MILLION : 23

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1982	1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX 1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.11	.12	.11
SALT LAKE CITY-OGDEN, UT	.14	.14	.17
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	.15	.15	.20
MEMPHIS, TN-AR-MS	.12	.15	.13
LOUISVILLE, KY-IN	.17	.16	.15
NASHVILLE-DAVIDSON, TN	.11	.12	.13
BIRMINGHAM, AL	15	.15	.11
OKLAHOMA CITY, OK	.12 *	.11	.12
DAYTON, OH	[illegible]	.13	.12
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.11	.12	.11
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.11	.13	.12
ALBANY-SCHENECTADY-TROY, NY	12	.12	.09
TOLEDO, OH-MI	.13	.13	.11

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1982		1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX 1983	1984
POPULATION: .5 - 1 MILLION (CONT)				
HONOLULU, HI	.07		.06	.07
JACKSONVILLE, FL	.12		.14	.11
HARTFORD, CT	.17		.19	.17
ORLANDO, FL	.10	*	.11	.11
TULSA, OK	.13		.13	.13
AKRON, OH	.14		.13	.11
GARY-HAMMOND-EAST CHICAGO, IN	.13		.17	.15
SYRACUSE, NY	.12		.08	ND
NORTHEAST PENNSYLVANIA	.16		.13	.11
CHARLOTTE-GASTONIA, NC	.12		.15	.13
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	.15		.14	.13
RICHMOND, VA	.12		.14	.13
GRAND RAPIDS, MI	.11		.13	.11

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE

STANDARD METROPOLITAN STATISTICAL AREA	OZONE HIGHEST 1982	1-HR CONCENTRATION (PPM) 2ND HIGH DAILY MAX 1983	1984	
POPULATION: .5 - 1 MILLION (CONT)				
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	.16	.19	.19	
WEST PALM BEACH-BOCA RATON, FL	.09	.12	.09	
OMAHA, NE-IA	.09	.09	.10	
GREENVILLE-SPARTANBURG, SC	.11	.11	.08	*
JERSEY CITY, NJ	.14	.16	.13	
AUSTIN, TX	.11	.12	.11	
YOUNGSTOWN-WARREN, OH	.11	.11	.09	
TUCSON, AZ	.12	.11	.11	
RALEIGH-DURHAM, NC	.0	.13	.10	
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	.16	.19	.17	
OXNARD-SIMI VALLEY-VENTURA, CA	.22	.21	.16	
WILMINGTON, DE-NJ-MD	.16	.18	.14	
FLINT, MI	[illegible]	.11	.09	

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

TABLE 4-7

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

OZONE CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 8

STANDARD METROPOLITAN STATISTICAL AREA	OZONE CONCENTRATION (PPM) HIGHEST 1-HR 2ND HIGH DAILY MAX 1982	1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.16	.16	.15
LONG BRANCH-ASBURY PARK, NJ	ND	ND	ND
TOTAL SMSA'S .5 - 1 MILLION : 41			

* LESS THAN 50% OF DAYS IN OZONE SEASON
ND = NO DATA

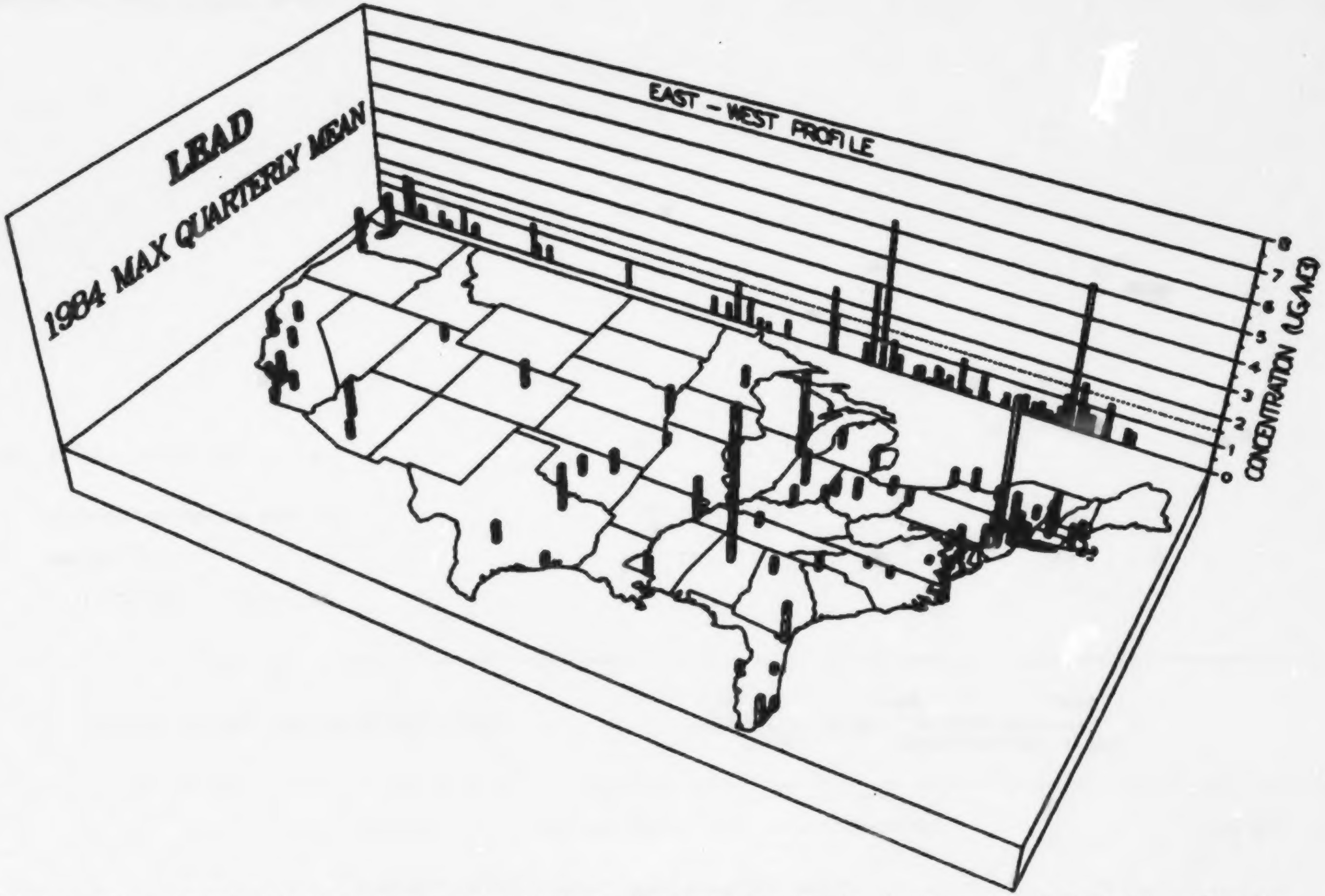

LEAD
1984 MAX QUARTERLY MEAN
EAST - WEST PROFILE
CONCENTRATION (UG/M3)
0
1
2
3
4
5
6
7
8

Figure 4-8. United States Map of the Highest Maximum Quarterly Average Lead Concentration by SMSA, 1984

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 1

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1982	1983	1984
POPULATION: > 2 MILLION			
NEW YORK, NY-NJ	.62	.90	.91
LOS ANGELES-LONG BEACH, CA	1.65	1.04	1.02
CHICAGO, IL	.81	.79 M	.68
PHILADELPHIA, PA-NJ	1.57 *	3.66 *	5.13 *
DETROIT, MI	.43	.82 Q	.69 Q
SAN FRANCISCO-OAKLAND, CA	.55	.36	.50
WASHINGTON, DC-MD-VA	.71	.60	.49
DALLAS-FORT WORTH, TX	.71	1.33	1.52
HOUSTON, TX	.25	.44	.39
BOSTON, MA	1.08	.60	.51
NASSAU-SUFFOLK, NY	.72	.60	.67
ST. LOUIS, MO-IL	3.81 *	6.70 *	2.41 *
PITTSBURGH, PA	.41	.45	.47

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 2

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1982	1983	1984
POPULATION: > 2 MILLION (CONT)			
BALTIMORE,MD	.86	.60	.60
MINNEAPOLIS-ST. PAUL, MN-WI	7.97 *	.71	.65
ATLANTA, GA	.59	.70 M	.47 M
TOTAL SMSA'S > 2 MILLION : 16			

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 3

STANDARD METROPOLITAN STATISTICAL AREA	LEAD HIGHEST 1982	CONCENTRATION (UG/M3) MAXIMUM QUARTERLY AVERAGE 1983	1984
POPULATION: 1 - 2 MILLION			
NEWARK, NJ	.91	.55	.56
ANAHEIM-SANTA ANA-GARDEN GROVE, CA	.97	.59	.60
CLEVELAND, OH	.44	.36 M	.28 M
SAN DIEGO, CA	1.15	.55	.44
MIAMI, FL	1.51	1.39	.93
DENVER-BOULDER, CO	1.30 M	1.04	.90 M
SEATTLE-EVERETT, WA	.82 M	7.57 M*	1.56 M*
TAMPA-ST. PETERSBURG, FL	1.10	1.01	.23
RIVERSIDE-SAN BERNARDINO-ONTARIO, CA	.69	.55	.55
PHOENIX, AZ	1.24	1.08	1.29
CINCINNATI, OH-KY-IN	.51 M	.47 M	.44
MILWAUKEE, WI	.38	.63	.72
KANSAS CITY, MO-KS	.28	.33	.34

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REFRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 4

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1982	1983	1984
POPULATION: 1 - 2 MILLION (CONT)			
SAN JOSE, CA	.99	.54	.59
BUFFALO, NY	.85	.69	.51
PORTLAND, OR-WA	1.63	1.37	1.58
NEW ORLEANS, LA	.23	.23	.56
INDIANAPOLIS, IN	.49	.63	1.14
COLUMBUS, OH	.66 M	.57 M	.62 M
SAN JUAN, PR	1.69	1.30	1.30
SAN ANTONIO, TX	.72	.64	.67
FORT LAUDERDALE-HOLLYWOOD, FL	.74	.71	.23
SACRAMENTO, CA	.70	.68	.58

TOTAL SMSA'S 1 - 2 MILLION : 23

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 5

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1982	1983	1984
POPULATION: .5 - 1 MILLION			
ROCHESTER, NY	.26	.51	.67
SALT LAKE CITY-OGDEN, UT	ND	.81	.53
PROVIDENCE-WARWICK-PAWTUCKET, RI-MA	1.11	.93	.58
MEMPHIS, TN-AR-MS	1.30	1.17	1.41
LOUISVILLE, KY-IN	1.16 M	.73 M	.60 M
NASHVILLE-DAVIDSON, TN	1.00	.58	.36
BIRMINGHAM, AL	3.82 *	4.17 *	5.33 *
OKLAHOMA CITY, OK	.41	.51	.59
DAYTON, OH	.73 M	.53 M	.52 M
GREENSBORO-WINSTON-SALEM-HIGH POINT, NC	.40	.43	.18
NORFOLK-VIRGINIA BEACH-PORTSMOUTH, VA-NC	.33	.34	.29
ALBANY-SCHENECTADY-TROY, NY	.37	.30	.34
TOLEDO, OH-MI	.21	.18	ND

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 6

STANDARD METROPOLITAN STATISTICAL AREA	LEAD HIGHEST 1982	CONCENTRATION (UG/M3) MAXIMUM QUARTERLY AVERAGE 1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
HONOLULU, HI	.21	.23	.53
JACKSONVILLE, FL	1.72	1.15	1.26
HARTFORD, CT	.62 M	.42 M	.48 M
ORLANDO, FL	.35	.31	.21
TULSA, OK	.48	.69	.75
AKRON, OH	.22 M	.20 M	.15 M
GARY-HAMMOND-EAST CHICAGO, IN	1.72 *	.66	2.95 *
SYRACUSE, NY	.28	.34	.36
NORTHEAST PENNSYLVANIA	.56	.31	.29
CHARLOTTE-GASTONIA, NC	.79	ND	ND
ALLENTOWN-BETHLEHEM-EASTON, PA-NJ	1.01	.76	1.13
RICHMOND, VA	.26	.36	.14
GRAND RAPIDS, MI	ND	.78	.66

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REFRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

LEAD CONCENTRATION BY SMSA POPULATION RANGE PAGE NO: 7

STANDARD METROPOLITAN STATISTICAL AREA	LEAD CONCENTRATION (UG/M3) HIGHEST MAXIMUM QUARTERLY AVERAGE 1982	1983	1984
POPULATITON: .5 - 1 MILLION (CONT)			
NEW BRUNSWICK-PERTH AMBOY-SAYREVILLE, NJ	ND	2.12 *	1.73 *
WEST PALM BEACH-BOCA RATON, FL	.32	.25	.33
OMAHA, NE-IA	1.59 *	1.23	.91
GREENVILLE-SPARTANBURG, SC	.79	.24	.49
JERSEY CITY, NJ	.71	.51	.94
AUSTIN, TX	ND	.53	ND
YOUNGSTOWN-WARREN, OH	.24	.29	ND
TUCSON, AZ	.58	.65	.59
RALEIGH-DURHAM, NC	.43	.42	.23
SPRINGFIELD-CHICOPEE-HOLYOKE, MA-CT	1.14	1.00	1.29
OXNARD-SIMI VALLEY-VENTURA, CA	.46	.37	.33
WILMINGTON, DE-NJ-MD	1.24	1.81 *	.63
FLINT, MI	.15	.24	.16

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REFRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA
* = THIS LEVEL REFLECTS THE IMPACT OF INDUSTRIAL SOURCES.

TABLE 4-8

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

STANDARD METROPOLITAN STATISTICAL AREA	LEAD HIGHEST 1982	CONCENTRATION (UG/M3) MAXIMUM QUARTERLY AVERAGE 1983	1984
POPULATION: .5 - 1 MILLION (CONT)			
FRESNO, CA	.92	.70	.60
LONG BRANCH-ASBURY PARK, NJ	ND	ND	ND

TOTAL SMSA'S .5 - 1 MILLION : 41

M = REPRESENTS MONTHLY COMPOSITE DATA
Q = REPRESENTS QUARTERLY COMPOSITE DATA
ND = NO DATA

5. TREND ANALYSIS FOR TEN URBANIZED AREAS

This chapter presents trends in ambient air quality for 1980 through 1984 in ten urbanized areas. The ten urbanized areas included in this analysis are Atlanta, GA; Boston, MA; Chicago, IL-Northwestern IN; Denver, CO; Houston, TX; Los Angeles-Long Beach, CA; New York, NY-Northeastern NJ; Philadelphia, PA-NJ; Portland, OR-WA; and St. Louis, MO-IL. These cities were selected because they were among the largest cities in each of the EPA Regions. Where sufficient data were available, trends are presented for the criteria pollutants TSP, SO_2, CO, NO_2, O_3, and Pb.

The air quality data used for the trend statistics in this section were obtained from the EPA National Aerometric Data Bank (NADB). Additionally, some data were taken from State annual reports. The monitoring sites used for the trend analysis were required to satisfy the historical continuity criteria of 4 out of 5 years of data in the period 1980 to 1984. Furthermore, each year with data generally had to meet the annual data completeness criteria as described in Section 2.1.

The urbanized area air quality trends focuses on the period 1980 through 1984. This complements the national trend analyses in Section 3 which examines both a 10-year trend (1975 to 1984) and a 5-year trend (1980 to 1984). Although some of the ten urbanized areas had sufficient data to prepare area trends for the ten year period (1975 to 1984), several of the urbanized areas did not have sufficient data to meet the 8 of 10 year data completeness criteria. As a result of this situation and considering the fact that the ten urbanized areas began establishing fixed long-term National Air Monitoring Stations in 1980, it was decided to begin the urbanized area trends analysis in 1980.

The trends analyses are based on monitoring sites located within the boundaries of the urbanized areas (except for O_3) included in the 1980 Census of Population Report prepared by the U.S. Bureau of Census.[1] The report describes an urbanized area as consisting of a central city or cities, and surrounding closely settled territory (urban fringe). Since the maximum O_3 concentrations generally occur downwind of an urbanized area, the downwind sites located outside of the urbanized area boundaries were also used in the trends analysis.

Maps of the appropriate urbanized area are included as part of the discussions on urban area trends. The maps include county and urban area boundaries and were obtained from the Bureau of Census maps, while the city boundaries are the best estimates of the actual city borders. The locations of the monitoring sites shown on the maps are for sites having at least 4 years of data during 1980-1984 and which were used in the trend analysis. The maps are presented for illustrative purposes to show the spatial distribution of monitoring sites.

Figure 5-1 shows the plotting convention used in trends analysis. For 1980-1984, the maximum and minimum values as well as the composite average of the sites used in the trends are shown. The maximum and minimum values are measured concentrations, while interpolated values for missing years were used to calculate the appropriate average. Table 5-1 shows the air quality statistics used in the trend analyses for the ten cities. It should also be noted on the TSP trend plots for all cities, except Houston, that the composite averages for 1980-1982 are connected by dotted lines. As previously explained in Section 3.1.1, EPA has found that TSP data collected in 1980 and 1981 may be biased high due to the glass fiber filter used during these years. The apparent decrease in TSP concentrations between 1981 and 1982 can be partially attributed to a change in the filters. In Houston during 1981 and 1982, a combination of several different types of filters were used which may have resulted in an unknown bias.[2]

The air quality data and trends presented in this section should not be used to make direct city to city comparisons since the mix, configuration, and number of sites comprising the area network are different. Furthermore, other parameters such as population density, transportation patterns, industrial composition, emission inventories, and meteorological characteristics also need to be taken into consideration.

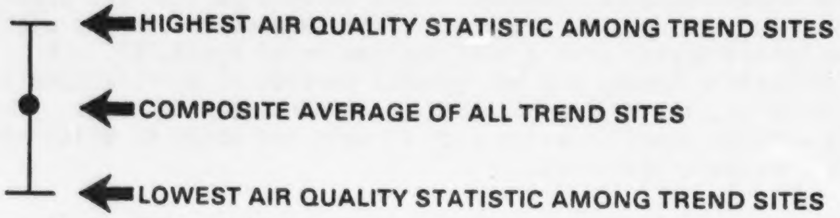

HIGHEST AIR QUALITY STATISTIC AMONG TREND SITES
COMPOSITE AVERAGE OF ALL TREND SITES
LOWEST AIR QUALITY STATISTIC AMONG TREND SITES

FIGURE 5-1. ILLUSTRATION OF PLOTTING CONVENTIONS FOR RANGES USED IN URBANIZED AREA TREND ANALYSIS.

Table 5-1. Air Quality Trend Statistics and Their Associated National Ambient Air Quality Standards (NAAQS)

POLLUTANT	TREND STATISTICS	PRIMARY NAAQS CONCENTRATION
Total Suspended Particulate	annual geometric mean	75 ug/m^3
Sulfur Dioxide	annual arithmetic mean	80 ug/m^3 (0.03 ppm)
Carbon Monoxide	second highest nonoverlapping 8-hour average	10 mg/m^3 (9 ppm)
Nitrogen Dioxide	annual arithmetic mean	100 ug/m^3 (0.053 ppm)
Ozone	second highest daily maximum 1-hour average	235 ug/m^3 (0.12 ppm)
Lead	maximum quarterly average	1.5 ug/m^3

ug/m^3 = micrograms per cubic meter

ppm = parts per million

mg/m^3 = milligrams per cubic meter

5.1 BOSTON, MASSACHUSETTS URBANIZED AREA

The Boston urbanized area, located in the eastern part of the State, is the largest urbanized area in the State of Massachusetts and the eighth largest in the United States with a 1980 population of 2,678,762. It includes all of Suffolk County and the greater portion of Norfolk County plus portions of Plymouth, Middlesex, Essex, and Worcester Counties. The urbanized area extends about 51 miles east to west and about 46 miles north to south at the greatest distances.

The Boston basin, a territory within a range of hills, has rolling topographical physical features, and is split by the Charles and Mystic Rivers. Because of the confinement, many tall buildings and light industrial, commercial, and residential land use complexes are in close proximity of each other. Numerous small factories and a great diversification of industries are found in this area including electrical, food, printing and publishing, transportation equipment, fabricated metal, and rubber products. Boston is the chief United States' Atlantic Ocean fishing port. A large network of railroads and truck lines serve this port.

The meteorology of the area is complex. Prevailing winds are from the northwest in the winter and southwest in the summer. During the summer, the land, sea-breeze effect allows pollutants to be transported out over the sea and then returned to the inland area.

The locations of the monitors used in the pollutant trend graphs are provided in Figure 5-2 and 5-3. The trend graphs are displayed in Figure 5-4.

5.1.1 TSP Trends

Twenty-two sites were operated during the period 1980-1984; six sites had 4 or more years of valid data. There was a 22 percent decline in the highest TSP levels and an 18 percent decline in the composite average concentrations comparing the 1980 to the 1984 levels. The trend is similar to the national trend of 21 percent. The lowest TSP concentrations were measured at a site in a residential area while the highest concentrations were measured in the industrial areas of Boston. Unlike the national trend, there was no decrease in the geometric mean from 1981 to 1982. As noted in Section 3.1.1, some of the national decrease in TSP from 1981 to 1982 may be attributed to a change in the filters. In the case of the Boston urbanized area, the lack of a decrease may be due to the drier conditions in the northeast in 1982 than in 1981.[3]

5.1.2 Pb Trends

There were six sites that reported data during the years of 1980-1984; however, no site met the completeness criteria; therefore, no trend is possible for the Boston area.

5.1.3 SO_2 Trends

Nineteen SO_2 sites were operated between 1980 and 1984. Figure 5-4 shows the trend for five sites meeting the trend criteria. Comparing the 1980 composite annual mean to the 1984 value, there was a 21 percent decline while the decline seen at the national level is 15 percent. The higher rate of decline in the SO_2 levels for Boston may be related to meteorology and fuel conservation. The highest levels were measured at a site located in the industrial area of Boston and the lowest levels were measured at a site located in a residential area of Medfield.

5.1.4 O_3 Trends

Figure 5-3 shows the trends for the two sites having 4 years of complete data out of the ten sites that operated during the period 1980-1984. The trends in the O_3 levels fluctuated during this period; however, the composite average levels showed increases of 4 percent between 1980 and 1984 and 21 percent between 1982 and 1983. Meteorology in 1983 may have partially affected the higher O_3 levels during this year.

5.1.5 NO_2 Trends

Seven sites reported NO_2 data during the period 1980-1984, and two sites had 4 or more years of valid data. Comparing the 1980 to the 1984 levels, there was a 4 percent decline in the composite average levels or slightly over one-half of the national average of 7 percent. The highest NO_2 levels were measured at a site located in an industrial area. The rate of decline in the NO_2 levels for Boston from 1980 to 1983 is 38%. This is contrasted by a 73 percent increase from 1983 to 1984. The reason for this increase is not apparent; and since it was determined from only two sites, it is difficult to draw conclusions from these data.

5.1.6 CO Trends

Three of the ten sites that operated during the period 1980-1984 met the criteria of having 4 years of complete data. The data reported from these three sites indicate an increase of 1 percent in the CO levels in this urbanized area. In contrast, there was a 10 percent decline at the national level. Composite average levels showed an increase of 1 percent between 1980 and 1984. From 1980 to 1982, there was a dramatic 60% increase in the trend statistic. This upward trend is attributed to urban redevelopment and traffic rerouting as the monitors were in areas where traffic volume increased significantly. Since 1982, the neighborhoods around the monitors have stabilized, and there has been a 37% decrease from 1982 to 1984. Generally, the highest levels were measured in heavy commercial areas of Boston and the lowest levels were measured in a light commercial and residential complex area of Boston. Although there was little change in the second highest nonoverlapping 8-hour average, there was a general improvement in the annual average CO levels between 1980 and 1984.[4]

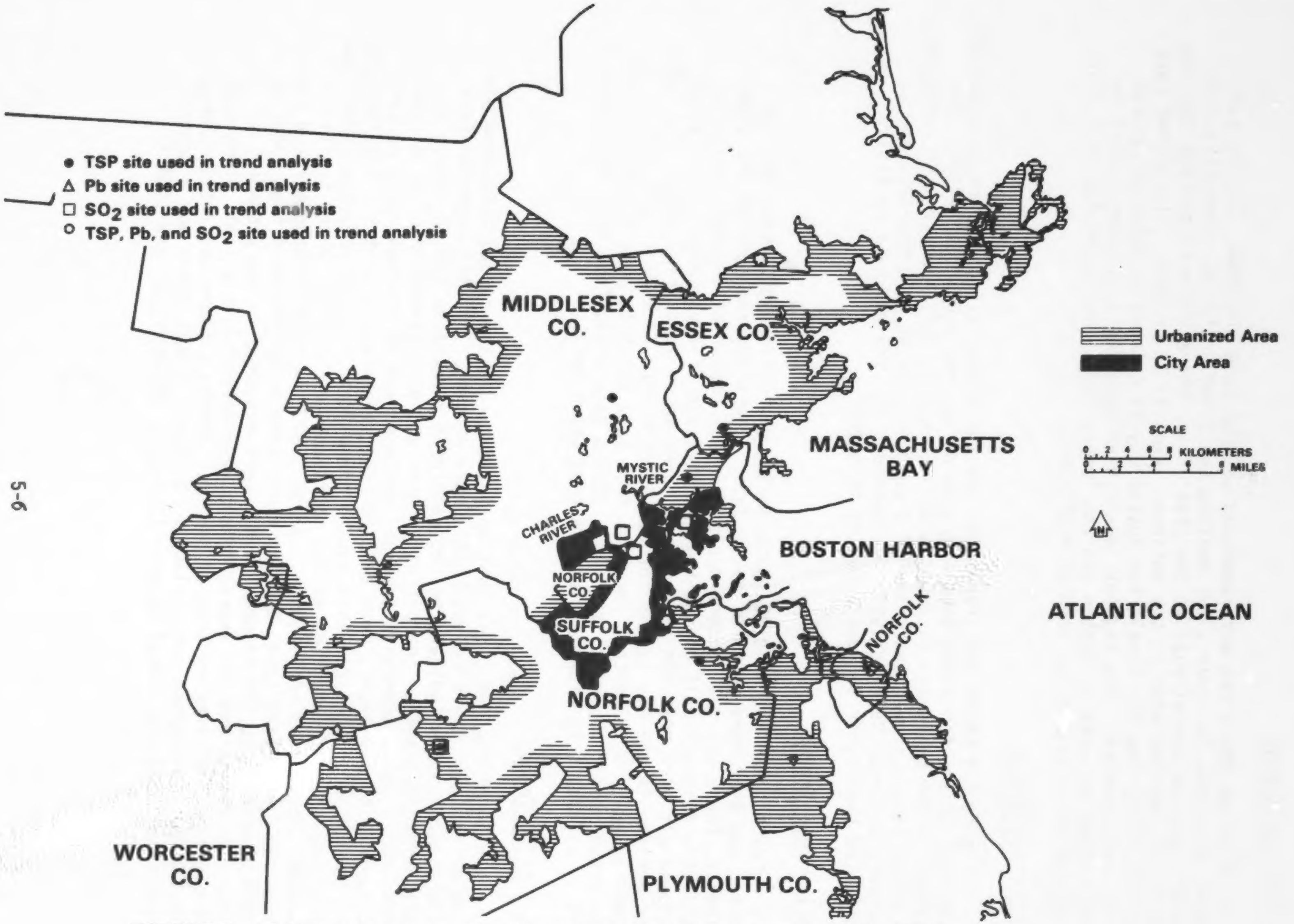

● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis
MIDDLESEX CO.
ESSEX CO.
MYSTIC RIVER
CHARLES RIVER
NORFOLK CO.
SUFFOLK CO.
NORFOLK CO.
NORFOLK CO.
WORCESTER CO.
PLYMOUTH CO.
MASSACHUSETTS BAY
BOSTON HARBOR
ATLANTIC OCEAN
Urbanized Area
City Area
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
N

FIGURE 5-2. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN BOSTON, MA, 1980-1984.

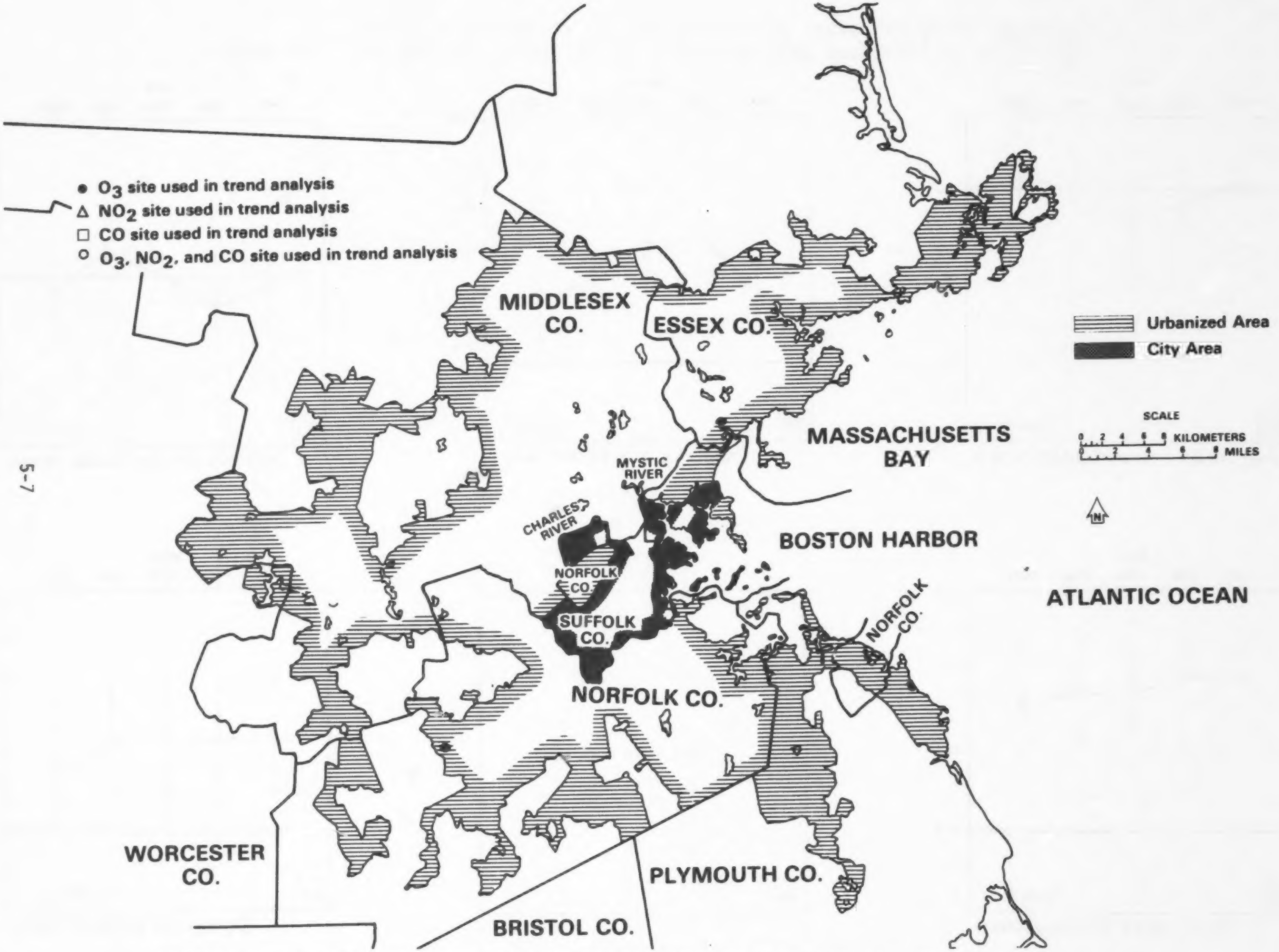

● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
MIDDLESEX CO.
ESSEX CO.
MYSTIC RIVER
CHARLES RIVER
NORFOLK CO.
SUFFOLK CO.
NORFOLK CO.
MASSACHUSETTS BAY
BOSTON HARBOR
NORFOLK CO.
ATLANTIC OCEAN
WORCESTER CO.
PLYMOUTH CO.
BRISTOL CO.
Urbanized Area
City Area
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES
N

FIGURE 5-3. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN BOSTON, MA, 1980-1984.

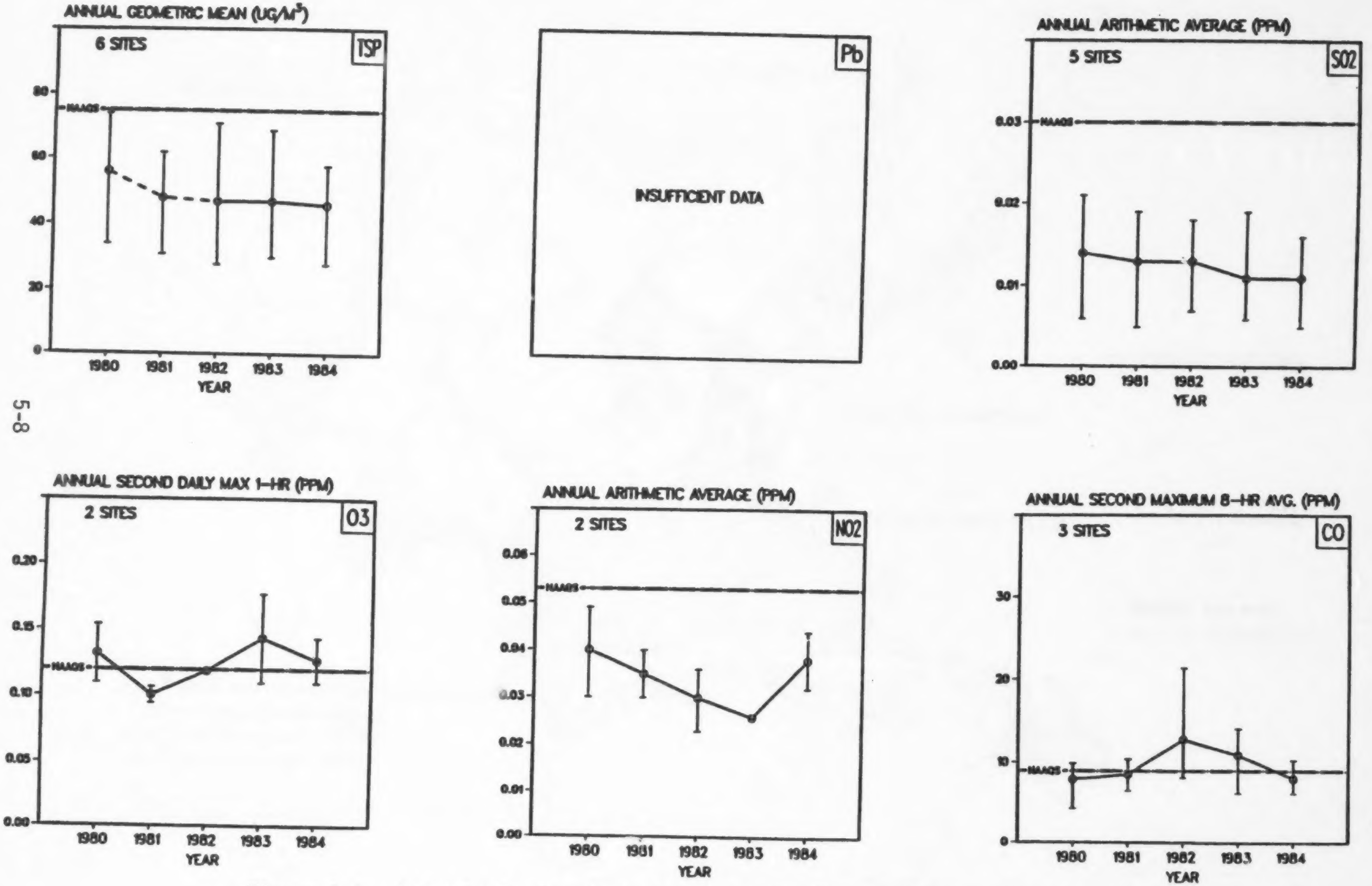


Figure 5-4. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Boston, MA Urbanized Area, 1980-1984.

5.2 NEW YORK, NEW YORK-NORTHEASTERN NEW JERSEY URBANIZED AREA

The New York urbanized area is the largest urbanized area in the United States with a 1980 population of 15,590,274. It includes all of Essex, Hudson, and Union Counties in New Jersey; all of Bronx, Kings, Nassau, New York, Queens, and Richmond Counties in New York; parts of Bergen, Middlesex, Monmonth, Morris, Ocean, Passaic, Somerset, and Sussex Counties in New Jersey; and parts of Putnam, Rockland, Suffolk, and Westchester Counties in New York. At its greatest distance, the urbanized area extends about 105 miles east to west and about 110 miles north to south.

The urbanized area is located at the mouth of the Hudson River in the northeastern part of the United States. As a major ocean port, it is the busiest in the United States. Industries have concentrated in the urbanized area because of the proximity to major markets and the easy access to transportation facilites. This urbanized area is the leading manufacturing area in the United States. The largest manufacturing industries are apparel and other finished products; printing, publishing, and allied industries; food products; machinery; chemical and allied products; fabricated metal products; textile products; leather and leather products; paper products; auto and aircraft production; and shipbuilding.

The urbanized area is close to the path of most frontal systems which move across the United States. Extremes of hot weather which may last up to 1 week are associated with air masses moving over land from a Bermuda high pressure system. Extremes in cold weather are from rapidly moving outbreaks of cold air moving southeastward from the Hudson Bay region. The average rainfall is around 41 inches per year.

The maps showing the locations of the monitoring sites used in the trend analysis are shown in Figure 5-5 and Figure 5-6. The trend graphs for the pollutants are shown in Figure 5-7 and depict the trends for 1980-1984. However, this 5-year period is not indicative of the overall air quality progress achieved prior to 1980.

5.2.1 TSP Trends

There were 105 sampling sites (52 in New Jersey and 53 in New York) that reported TSP data during 1980-1984, and of these 105 sites, 38 met the 4 out of 5-year data completeness criteria (17 in New Jersey and 21 in New York). Figure 5-5 shows the location of the 38 sites, and Figure 5-7 shows the trend graph of the 38 sites for 1980-1984 in which the composite average decreased 13 percent as compared to the national average of 21 percent for the same period. The highest measured concentrations were in the heavily industrialized areas of New Jersey and the lowest concentrations were in the residential areas of Long Island. Some of the decrease from 1981 to 1982 can be attributed to a change in the filters (see Section 3.1.1).

5.2.2 Pb Trends

Pb was sampled at 23 sites during 1980-1984. No site met the data completeness criteria and no trends are depicted for Pb. The available data show maximum quarterly concentrations for 1984 of around 0.5 to 1.0 ug/m^3 at traffic-oriented sites and 0.3 to 0.7 at non-traffic oriented sites. The highest concentrations during 1980-1984 were measured in New Brunswick, NJ near a battery manufacturing facility (1.73 ug/m^3 in 1984.)

5.2.3 SO_2 Trends

There were 54 sites which reported some data in the period 1980-1984, but only 19 sites met the data completeness criteria. The SO_2 levels increased 1 percent as compared to the national average of a 15 percent decrease (Figure 5-7). The highest concentrations during the period were measured in New York County (Manhattan) and are attributed to apartment buildings using oil for heating. While the overall annual mean levels increased 1 percent, the composite New York City borough sites decreased about 8 percent, the remaining New York county sites increased 11 percent and the composite of the New Jersey sites increased 9 percent.

5.2.4 O_3 Trends

A total of 27 sites monitored for O_3 during 1980-1984 and 10 of these sites met the criteria for completeness and were used in the trend analysis. The trends follow the national pattern in that there was a decrease for 1980-1982, an increase in 1983, and a decrease in 1984. From 1980-1984, the New York O_3 levels decreased 10 percent while the national levels decreased 9 percent for the same period. The composite average concentrations were above the NAAQS for each year during 1980-1984, and except for 1982, all the minimum trend sites were also above the NAAQS.

5.2.5 NO_2 Trends

The NO_2 trends for five sites that met the completeness criteria in the urbanized area show the same concentrations for 1980 and 1981, an increase in 1982, and similar levels through 1984. The five sites are a subset of the 21 sites that reported data for 1980-1984. The overall trend for 1980-1984 was a 6 percent increase, which is the reverse of the national decline of 7 percent. Part of this increase has been attributed to the decline in usage of the mass transit system and an increase in vehicular traffic.

5.2.6 CO Trends

There were 24 sites which measured CO during 1980-1984 and 11 sites met the data completeness criteria. The CO composite average increased 2 percent as compared to the national decrease of 10 percent for the same period. The highest concentrations were measured in street canyons in Manhattan, Jersey City, and Elizabeth. The New Jersey portion of the urbanized area increased 6 percent from 1980 to 1984 while the New York portion decreased 6 percent.

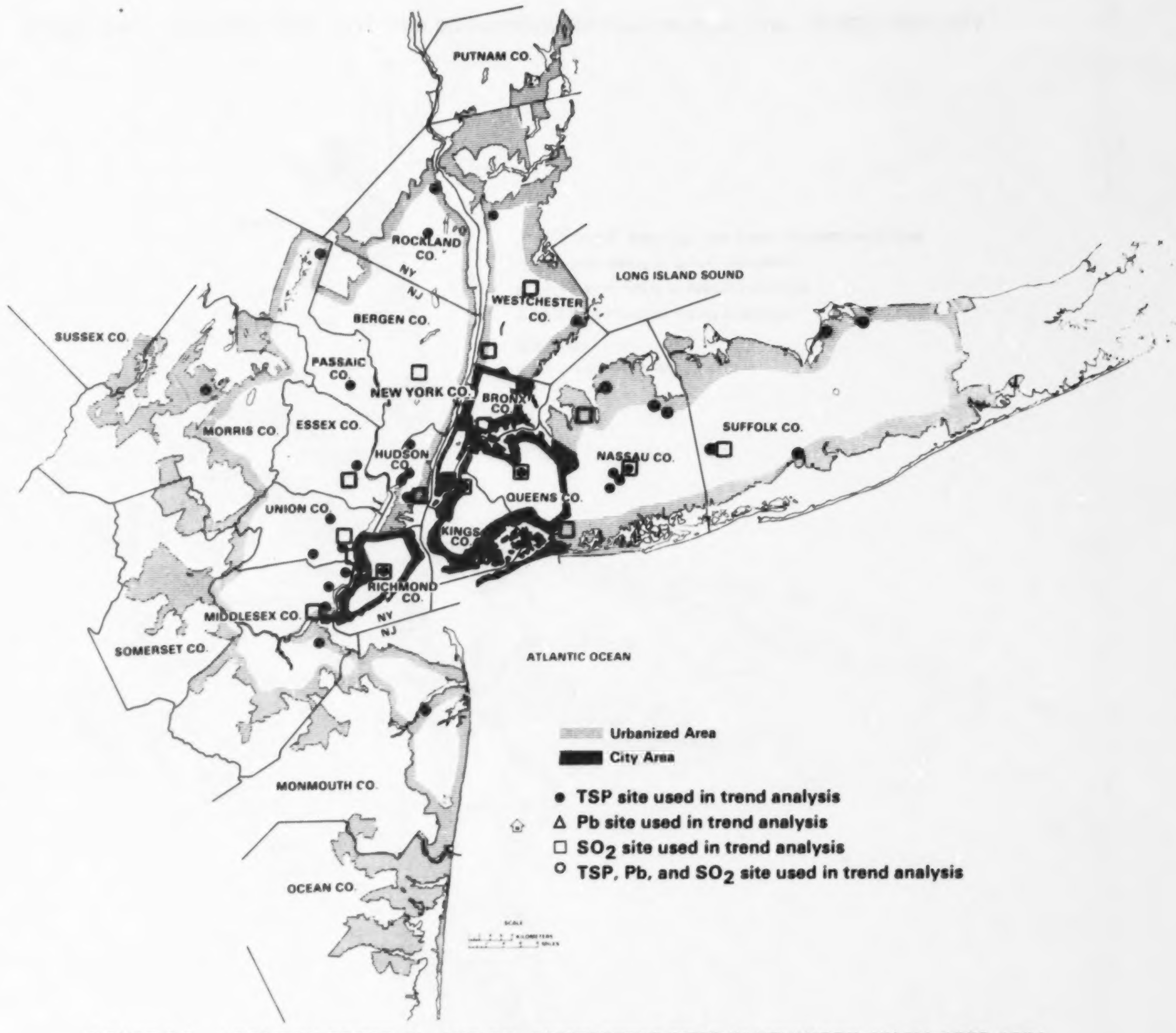

PUTNAM CO.
ROCKLAND CO.
NY
NJ
SUSSEX CO.
BERGEN CO.
PASSAIC CO.
NEW YORK CO.
WESTCHESTER CO.
LONG ISLAND SOUND
BRONX CO.
MORRIS CO.
ESSEX CO.
HUDSON CO.
NASSAU CO.
SUFFOLK CO.
QUEENS CO.
UNION CO.
KINGS CO.
RICHMOND CO.
MIDDLESEX CO.
SOMERSET CO.
ATLANTIC OCEAN
MONMOUTH CO.
OCEAN CO.
Urbanized Area
City Area
● TSP site used in trend analysis
Δ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
SCALE

FIGURE 5-5. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN NEW YORK, NY-NJ, 1980-1984.

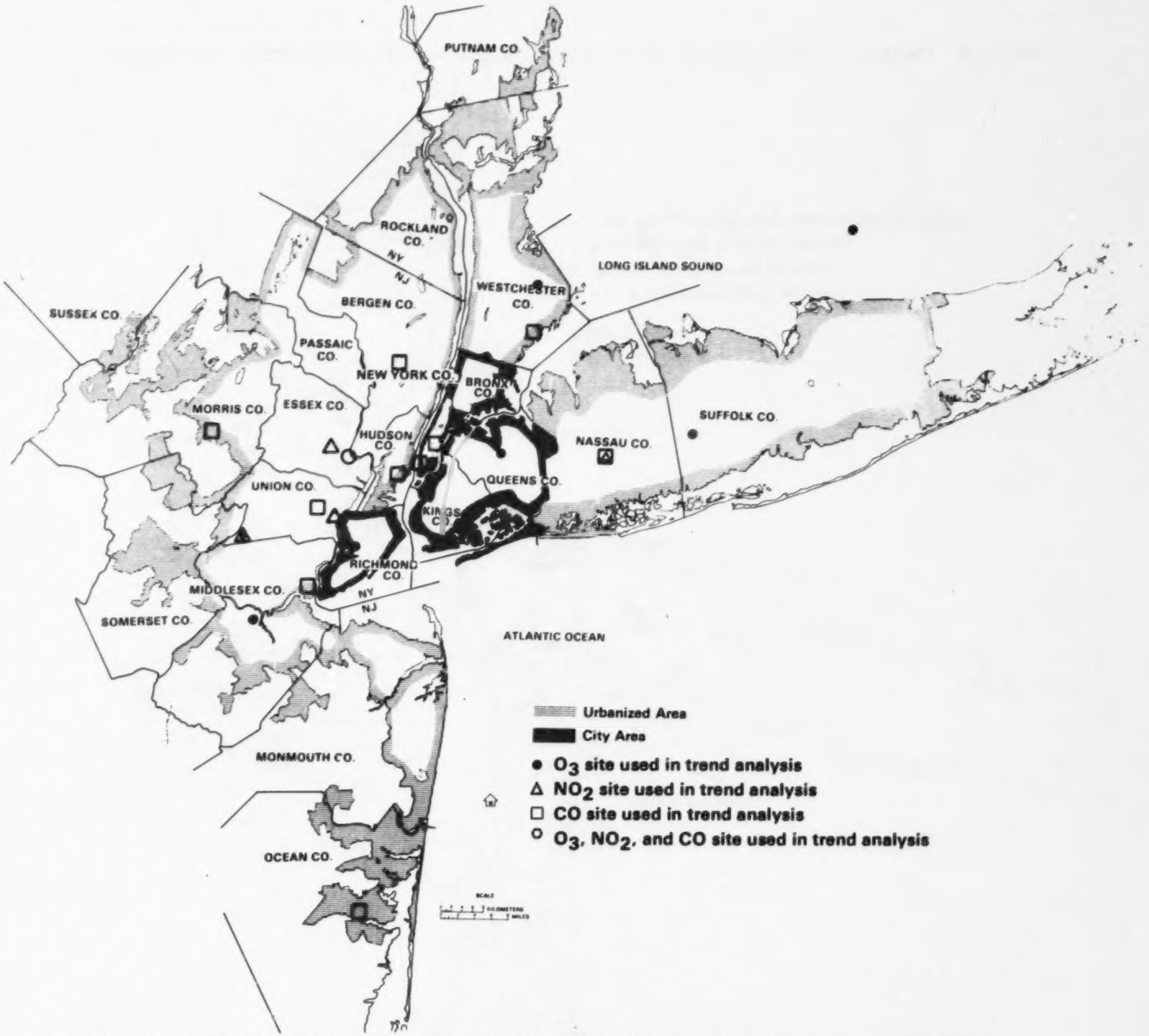

PUTNAM CO.
ROCKLAND CO.
NY
NJ
WESTCHESTER CO.
LONG ISLAND SOUND
SUSSEX CO.
BERGEN CO.
PASSAIC CO.
NEW YORK CO.
BRONX CO.
MORRIS CO.
ESSEX CO.
HUDSON CO.
NASSAU CO.
SUFFOLK CO.
QUEENS CO.
UNION CO.
KINGS CO.
RICHMOND CO.
MIDDLESEX CO.
NY
NJ
SOMERSET CO.
ATLANTIC OCEAN
MONMOUTH CO.
OCEAN CO.
Urbanized Area
City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
SCALE
KILOMETERS
MILES

FIGURE 5-6. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN NEW YORK, NY-NJ, 1980-1984.

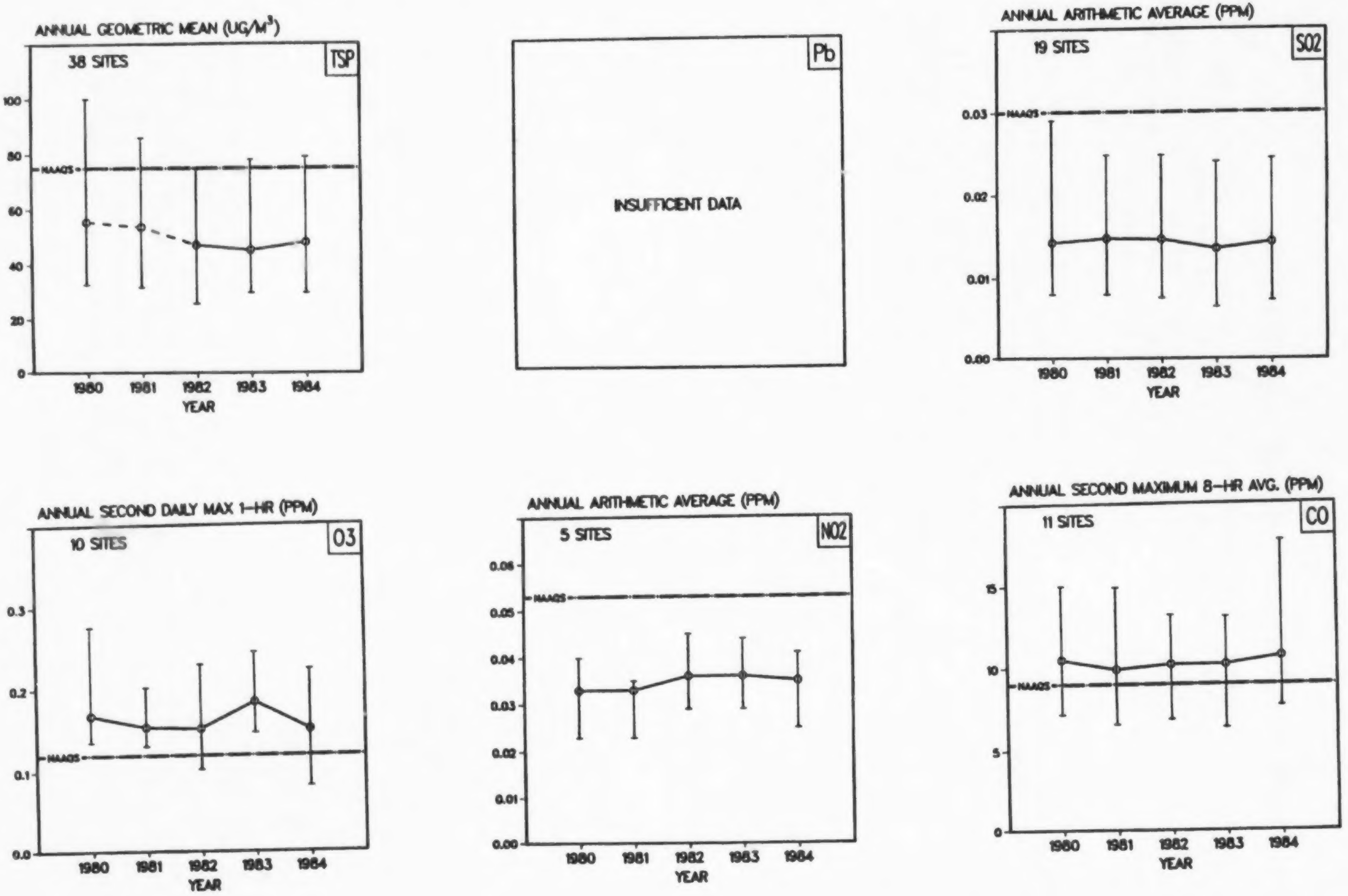


Figure 5.7. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the New York, NY-NJ Urbanized Area, 1980-1984.

5.3 PHILADELPHIA, PENNSYLVANIA-NEW JERSEY URBANIZED AREA

The Philadelphia, PA-NJ urbanized area is the fourth largest in the United States with a 1980 population of 4,112,933. It includes all of Philadelphia County plus portions of Bucks, Chester, Delaware, and Montgomery Counties in Pennsylvania and portions of Burlington, Camden, and Gloucester Counties in New Jersey. The urbanized area stretches about 65 miles east to west and about 50 miles north to south at its greatest distances.

Philadelphia is located in the southeastern corner of Pennsylvania on the Delaware River where the Schuylkill River flows into the Delaware. The Atlantic Ocean is 85 to 90 miles down the Delaware River. Philadelphia handles more shipping than any other port in the United States except for New York. The industrial growth of Philadelphia was due to its proximity to coal, petroleum, water power, and other natural resources. The leading industries in Philadelphia are manufacturing of textiles, carpets, clothing, paper, chemicals, glassware, oil refining, metalworking, ship building, sugar refining, printing, and publishing.

Concerning the meteorology of the urbanized area, the prevailing winds are from the southwest in the summer and from the northwest during the winter. Maritime air and the proximity to the Delaware River contribute to high humidity and temperatures during the summer months. The average rainfall is around 42 inches per year.

Figures 5-8 and 5-9 show the locations of the monitoring sites used in the trend analysis, and Figure 5-10 depicts the trend graphs for the pollutants.

5.3.1 TSP Trends

Figure 5-8 shows the location of 26 of the 37 sampling sites which met the data completeness criteria during 1980-1983. The TSP trend shown in Figure 5-10 is almost the same as the national trend in that the decrease in Philadelphia for 1980-1984 was 19 percent compared to the national decrease of 21 percent. The decrease for Philadelphia County was 15 percent while the remaining sites in Pennsylvania and New Jersey each showed a 24 percent decrease. Also, the 16 percent decrease in TSP levels from 1981 to 1982 is about the same as the national trend which has been attributed in part to the filters used for collecting the samples (see Section 3.1.1).

5.3.2 Pb Trends

There were 28 sites which sampled for Pb in the urbanized area during 1980-1984 and four of these sites are shown in the trend analysis. The composite average of these sites show an increase each year for the 5-year period. This upward trend is caused by one source-oriented Pb sampler which is located close to a plant which manufactures lead oxide pigment for paint. The three traffic oriented sites show a decrease from 1980 to 1984 of 24 percent. This compares with a 45 percent decrease in the national trend.

5.3.3 SO_2 Trends

The SO_2 concentrations were measured at 23 sites in the urbanized area. Ten of these sites met the data completeness criteria and were used in the trend analysis. The 20 percent decline from 1980 to 1984, while greater than the national decrease of 15 percent, appears to be consistent with Philadelphia's preliminary estimates of changes in emissions.[5] Area sources and refineries contributed to the SO_2 levels measured in the urbanized area.

5.3.4 O_3 Trends

Of the 11 sites that monitored O_3 in the urbanized area during 1980-1984, eight sites were selected for the trend analysis based on data completeness. The sites follow the national trend in decreases from 1980-1982 followed by an increase in 1983 and a decrease in 1984. The result was a 19 percent overall decrease from 1980-1984, as compared to the national decrease of 9 percent.

5.3.5 NO_2 Trends

Twelve sites monitored NO_2 during 1980-1984, and the trends for the seven sites meeting the completeness criteria are shown in Figure 5-9. The highest arithmetic average and the composite average of the seven sites were about the same for 1980-1984. The effect of mobile sources (which account for about 50 percent of the nitrogen oxide emissions) on the NO_2 sites may be the reason for the relatively unchanged NO_2 trends. Increasing traffic densities in the vicinity of the sites and decreasing NO_x emissions due to the Federal Motor Vehicle Emission Control Program could account for the stable trend.

5.3.6 CO Trends

Carbon monoxide was measured at 19 sites during 1980-1984 and six of these were used in the trend analysis. The composite CO levels at the six sites showed an increase from 1980 to 1981, decreases from 1981-1983, followed by an increase in 1984. There was an overall decrease of 4 percent from 1980 to 1984 which compares to the national decrease of 10 percent. The highest concentrations in 1982-1984 were from a microscale site which had insufficient data to be included in the trend analysis.

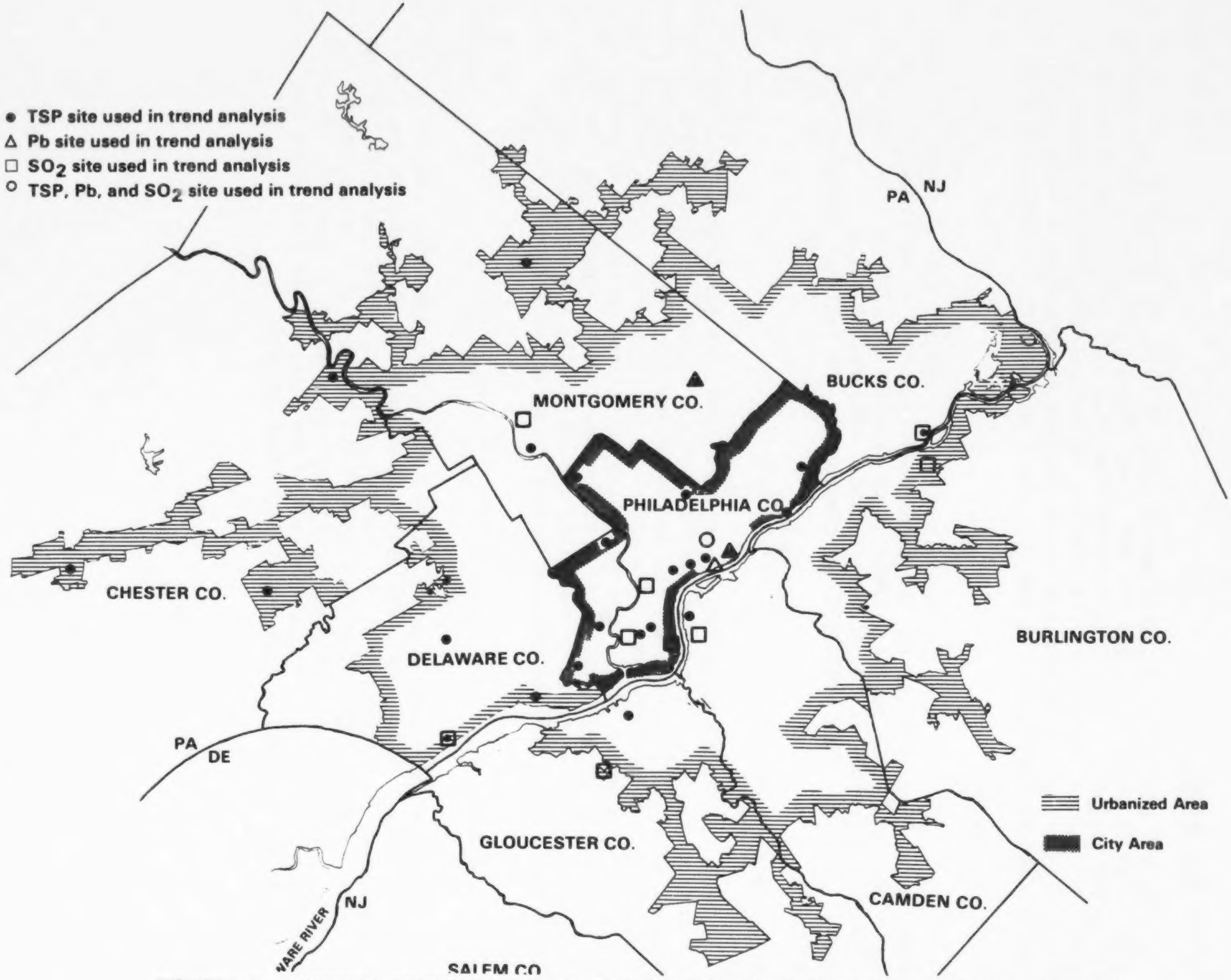

● TSP site used in trend analysis
Δ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
PA
NJ
BUCKS CO.
MONTGOMERY CO.
PHILADELPHIA CO.
CHESTER CO.
DELAWARE CO.
BURLINGTON CO.
PA
DE
GLOUCESTER CO.
CAMDEN CO.
NJ
WARE RIVER
SALEM CO
Urbanized Area
City Area

FIGURE 5-8. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN PHILADELPHIA, PA-NJ, 1980-1984.

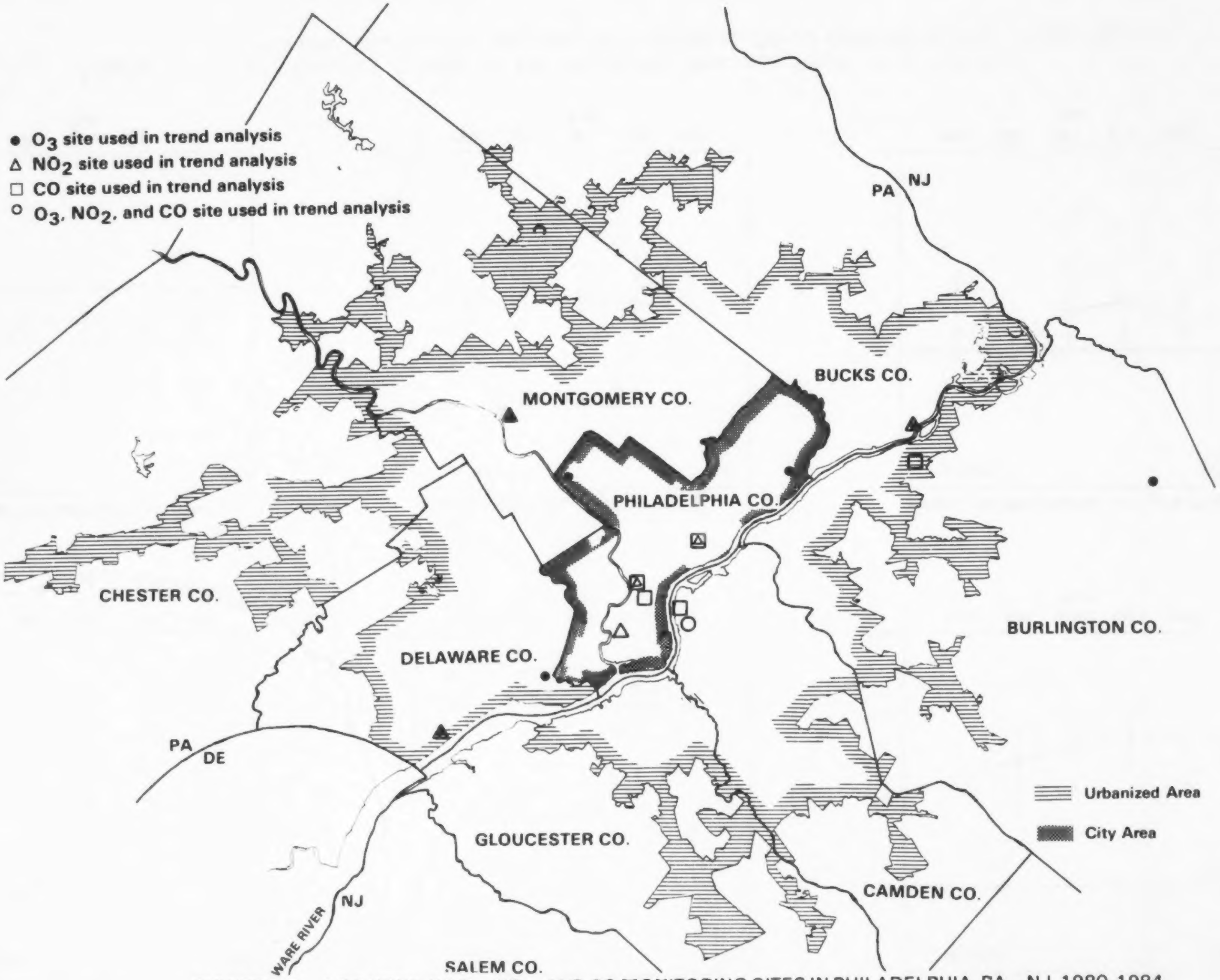

● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
PA
NJ
BUCKS CO.
MONTGOMERY CO.
PHILADELPHIA CO.
CHESTER CO.
DELAWARE CO.
BURLINGTON CO.
PA
DE
GLOUCESTER CO.
CAMDEN CO.
NJ
WARE RIVER
SALEM CO.
▤ Urbanized Area
▩ City Area

FIGURE 5-9. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN PHILADELPHIA, PA—NJ, 1980-1984.

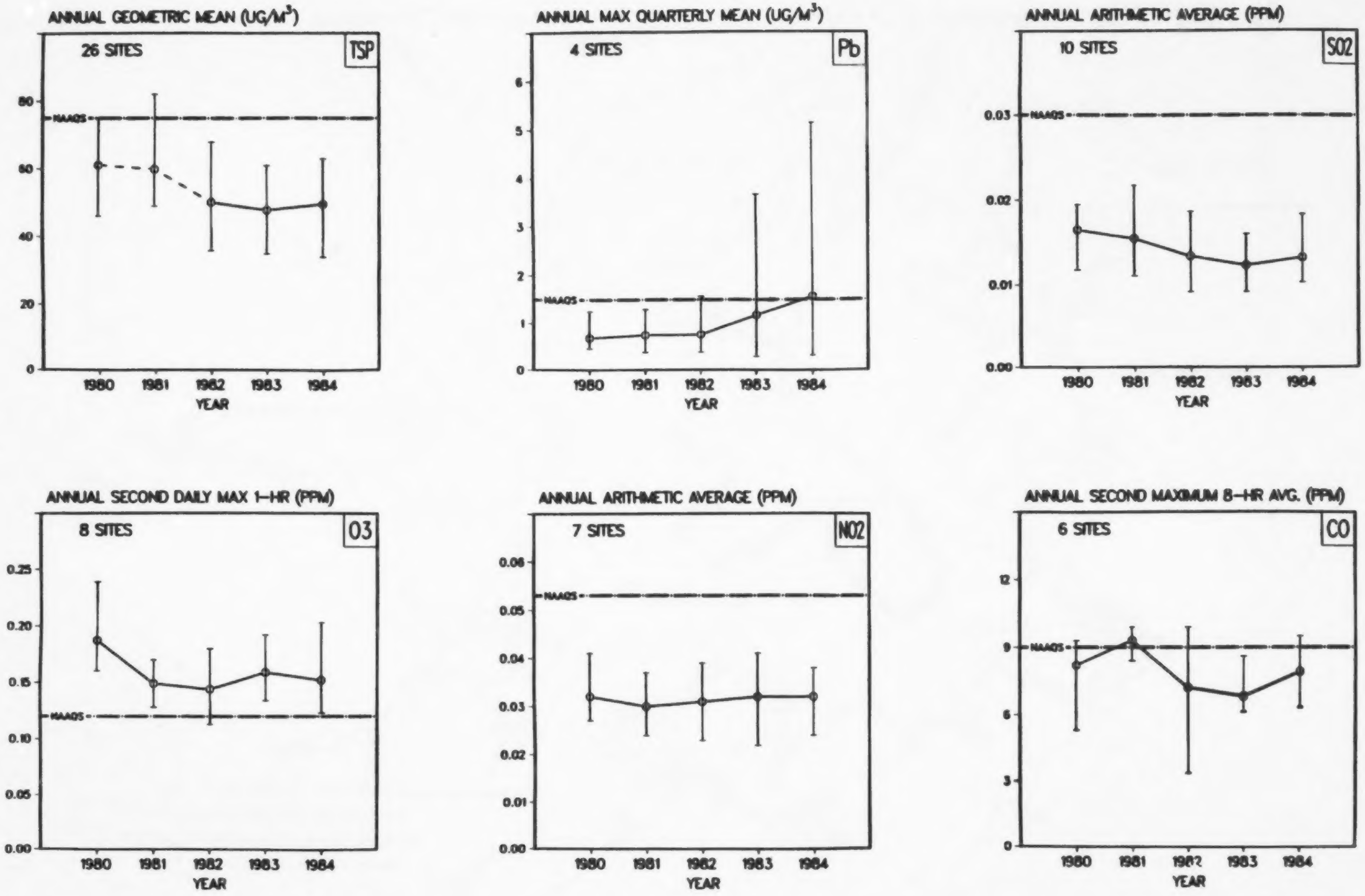


Figure 5-10. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Philadelphia, PA-NJ Urbanized Area, 1980-1984.

5.4 ATLANTA, GEORGIA URBANIZED AREA

Atlanta, the capital of Georgia and its largest city, is located in the north-central part of the State. The urbanized area of Atlanta is the most populous area between Washington, DC and New Orleans with a 1980 population of 1,613,357. The area extends into ten counties and measures approximately 40 miles north to south and 35 miles east to west. The majority of the people in the urbanized area live in Fulton, de Kalb, and Cobb Counties. Approximately 500 square miles of land area are included in this urbanized area.

The city is the financial and commerical capital of the southeast, the transportation and commercial center of the region, and an important distribution, manufacturing, educational, and medical center. Since its location is at the southern extreme of the Appalachian Range, it has become the gateway through which most overland and air traffic must pass from the eastern seaboard to the west. Atlanta is a rapidly growing and expanding area. The population increased by 37 percent since 1970. Atlanta has moderate summer and winter weather, with the summer winds from the northwest and the winter winds fluctuating from southwest to northwest. In spite of abundant rainfall, serious dry spells occur during most years.

The locations of the monitors used in the pollutant trend graphs are provided in Figures 5-11 and 5-12. The trend graphs are shown in Figure 5-13.

5.4.1 TSP Trends

Nineteen sites were operating for some time during the period 1980-1984 and nine of the sites had at least 4 years of valid data. The general location of these sites is shown on the map in Figure 5-11. Five of the nine sites were within the Atlanta city limits.

The composite average for the nine sites used to indicate the TSP trend for Atlanta showed a 16 percent decline, while the national decline was 21 percent. The highest annual mean was below the primary NAAQS for all years except 1981. The lower rate of air quality improvement compared to the national level may be due to Atlanta's rapid growth and to the long dry periods in 1982 and 1983. The higher TSP levels in 1980 and 1981 are probably due in part to the filters (Section 3.1.1). The highest levels were measured at a site located in a heavy commercial area and the lowest levels were measured at sites located in light commercial and residential areas.

5.4.2 Pb Trends

One Atlanta Pb site reported data during the 5-year period between 1980 and 1984, and met the data completeness criteria. However, there were no valid quarters reported for 1984 so the 1984 value was extrapolated from the 1983 level. The location of the Pb site is shown on the map in Figure 5-11.

The Pb levels showed a 16 percent decrease between 1980 and 1983, while the national trend indicated a 43 percent decrease. The 1980 to 1983 Pb levels at the Atlanta site were similar to the national composite levels. It is difficult to provide any conclusive statement about the Pb trends due to the sparsity of data.

5.4.3 SO_2 Trends

Atlanta operated one monitor during 1980 to 1984 which was relocated to a different site in 1982. Neither site met the data completeness criteria; therefore, no trend analysis was conducted.

5.4.4 O_3 Trends

There were two NAMS O_3 sites that met the criteria of having 4 or more valid years of data and the general location of these sites is shown on the map in Figure 5-12. For this urbanized area, the ozone season was assumed to run from March to November. The composite average of the second highest daily maximum hour was above the NAAQS for 4 out of the 5 years. Figure 5-13 shows the O_3 trend of plus 11 percent overall and depicts a saw-tooth pattern. The national trend was a minus 9 percent over 1980-1984. The meteorology in 1983 may have been more favorable for ozone formation than in 1981 and 1982.

5.4.5 NO_2 Trends

There were seven sites (three continuous monitoring sites) operating during the 1980-1984 study period, none of which met the data completeness criteria required for inclusion in the trend analysis.

5.4.6 CO Trends

There were six sites in the urbanized area and five of these sites met the criteria of 4 out of 5 valid years of data. The general location of these CO trend sites is shown on the map in Figure 5-12. Data from these five sites indicated an 18 percent decline in the Atlanta CO levels as compared to 10 percent nationally during this period. The greater percentage reduction than the national average could be attributed to the initiation of an automotive inspection maintenance program in 1981.

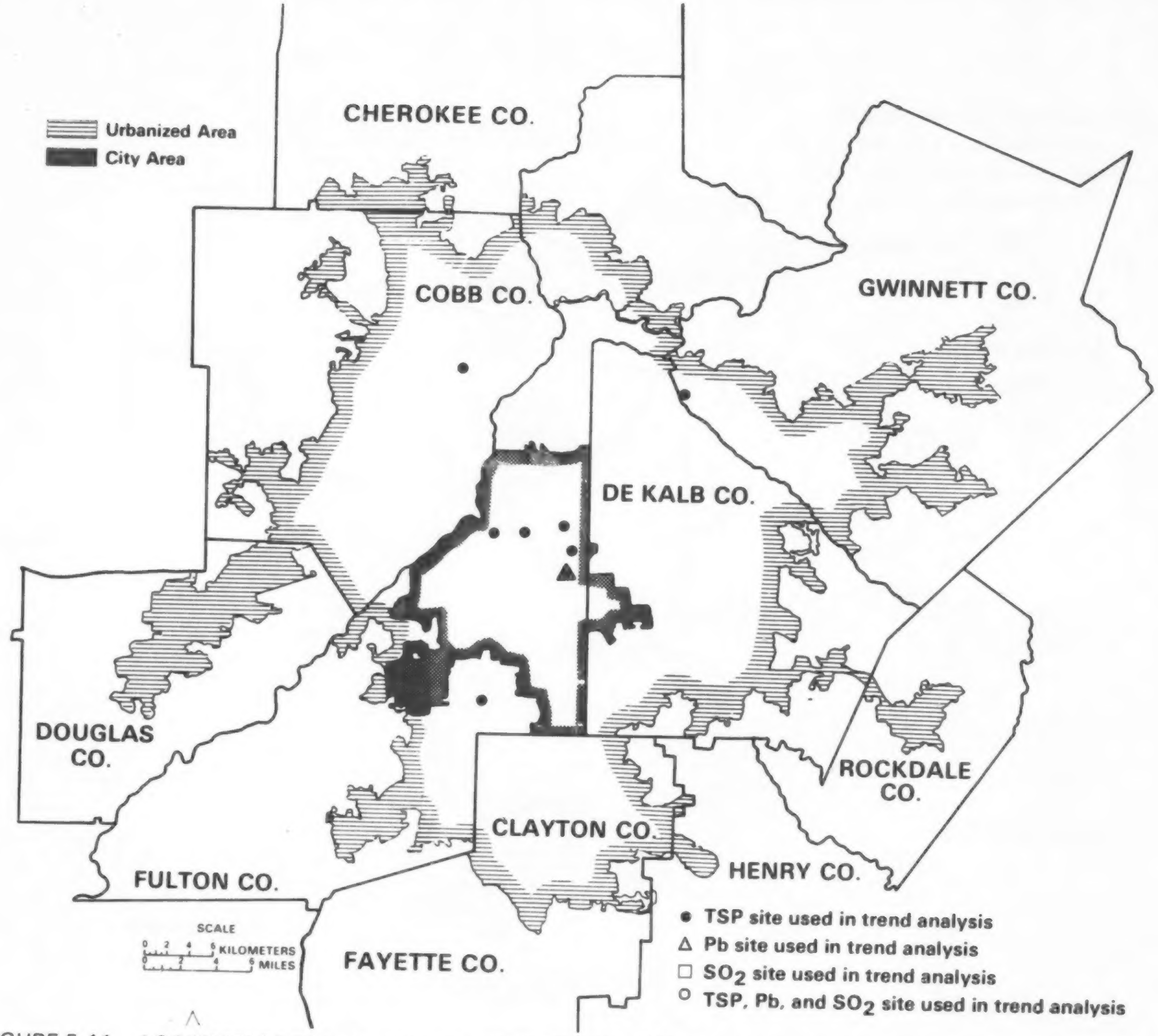

Urbanized Area
City Area
CHEROKEE CO.
COBB CO.
GWINNETT CO.
DE KALB CO.
DOUGLAS CO.
ROCKDALE CO.
CLAYTON CO.
HENRY CO.
FULTON CO.
FAYETTE CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO2 site used in trend analysis
○ TSP, Pb, and SO2 site used in trend analysis

FIGURE 5-11. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN ATLANTA, GA, 1980-1984.

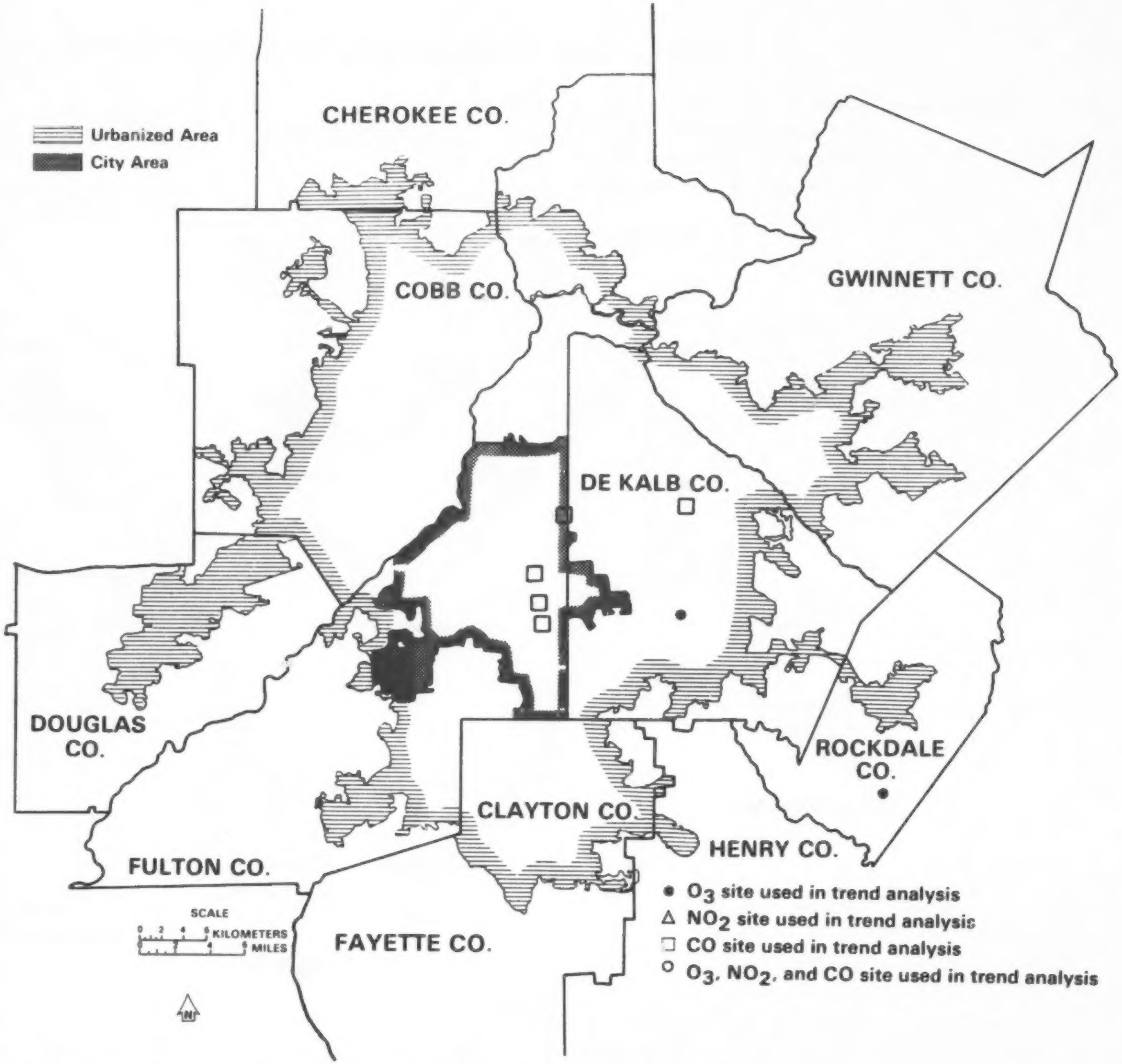

Urbanized Area
City Area
CHEROKEE CO.
COBB CO.
GWINNETT CO.
DE KALB CO.
DOUGLAS CO.
ROCKDALE CO.
CLAYTON CO.
HENRY CO.
FULTON CO.
FAYETTE CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis

FIGURE 5-12. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN ATLANTA, GA, 1980-1984.

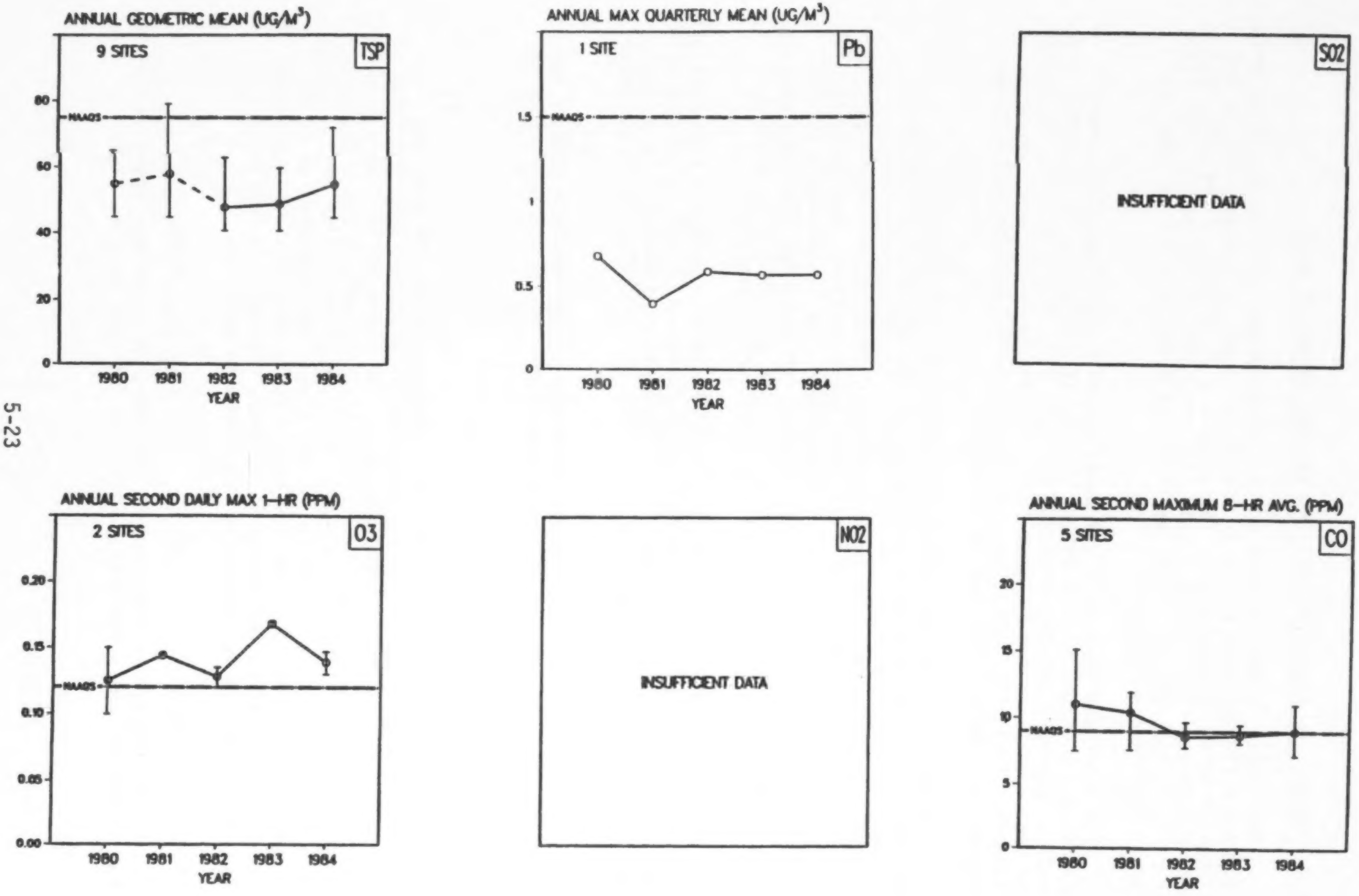


Figure 5-13. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Atlanta, GA Urbanized Area, 1980-1984.

5.5 CHICAGO, ILLINOIS-NORTHWESTERN INDIANA URBANIZED AREA

The Chicago urbanized area covers approximately 1300 square miles and includes 6,770,000 people. It is the third largest urbanized area in the nation in terms of population. Approximately 75 percent of the urbanized area population live in Cook County, the remaining 25 percent live in parts of Lake, Du Page and Will Counties in Illinois and portions of Lake and Porter Counties in Indiana.

The urbanized area runs from Waukegan (near the Wisconsin border) around Lake Michigan to Chesterton, Indiana to the east. The southern and western boundaries of the urbanized area are very irregular. To the south the area extends as far as Crown Point, Indiana and Park Forest South in Illinois. Similarly, the urban area extends as far west as Bartlett, West Chicago, and Napierville, all in Illinois.

Economically, Chicago is a major center for transportation, manufacturing, and commercial enterprises. In terms of transportation, Chicago has the largest air and rail traffic in the country. Because of Chicago's location and large manufacturing concerns, it has developed an extensive highway network for local and through traffic. Additionally, the port of Chicago on Lake Michigan has developed into an important inland port for raw materials and port of transfer for the Great Lakes-Atlantic trade. Among Chicago's chief manufactures are food products, primary metals (steel) and both elecrical and nonelectrical machinery.

Chicago occupies a relatively flat plains area bounded by Lake Michigan in the east. The climate is predominately continental with relatively warm summers and cold winters. Temperature extremes are somewhat altered by Lake Michigan and other Great Lakes. Annual precipitation is on the order of 33 inches per year.

Figures 5-14 and 5-15 show the locations of the monitors used in the trend analysis and Figure 5-16 shows the trends for all the pollutants in the urbanized area.

5.5.1 TSP Trends

Figure 5-14 shows the approximate location of the TSP sampling locations operated in the Chicago urbanized area between 1980 and 1984, that were used in the TSP trend analysis. The TSP trend in Figure 5-16 shows the composite average of 52 out of 97 sites meeting the trend criteria during the period between 1980-1984. The 25 percent decline in TSP values for the urbanized area is similar to the 5 year national decline of 21 percent over this period (1980 to 1984). While some of this improvement must be attributed to the change in filters, discussed in Section 3.1.1, some also appear to be related to reductions in emissions.

5.5.2 Pb Trends

During the period between 1980 and 1984, 74 sites were operated for lead in the Chicago urban area. Lead data for many of these sites have not been submitted to EPA; therefore the Illinois State Annual reports for 1980-1984 have been used as a supplemental source for lead data to develop a Chicago area trend.[6-10] There were 35 sites shown on Figure 5-14 having at least 4 years of valid data during the period and used to compute the composite average of highest quarterly lead concentration. The Chicago trend for the period 1980 to 1984 shows the same 45 percent decline as the 5-year national trend for lead.

5.5.3 SO_2 Trends

Twenty-one SO_2 monitoring sites operated in the Chicago area of which nine sites met the trend criteria with a minimum of 4 years of valid data. These sites are shown on Figure 5-14. The composite average of SO_2 values in Chicago has declined by approximately 17 percent between 1980 and 1984, which is close to the national decline of 15 percent.

5.5.4 O_3 Trends

The O_3 trend for Chicago is based on the six sites meeting the data completeness criteria out of the 28 sites operated during the period. The location of the trend sites is shown in Figure 5-15. The composite average of second daily maximum hour concentrations for Chicago shows patterns very similar to the national trend in that the composite averages decline each year between 1980 and 1982 with a pronounced 26 percent increase occurring between 1982 and 1983 followed by a pronounced decrease of 17 percent between 1983 and 1984 (Figure 5-16). As noted in Section 3.5.1, a meteorological index was developed for Chicago, which suggests that the 1982-83 increase in O_3 levels is partly attributable to meteorology.[11]

5.5.5 NO_2 Trends

During the period 1980 to 1984 there were 56 NO_2 monitoring sites operated in the urban area, 17 of which were used for the Chicago NO_2 trend. The location of these 15 sites is shown in Figure 5-15. Eight of the 56 sites utilized continuous monitors and the remaining 48 sites used bubblers. The composite annual average concentrations for the Chicago area are similar to the national trend for all sites. The composite average declined 23 percent for Chicago over the 5-year period, as compared to 7 percent for the nation. There is no apparent reason for the comparatively larger decline in the Chicago area.

5.5.6 CO Trends

The CO trends are based on 2 of the 13 sites operated during the period which met the data completeness criteria. The location of these sites is shown on Figure 5-15. During the time period, the CO composite averages declined by nearly 10 percent from 1980 through 1982 and then increased in 1983 followed by a sharp decline in 1984 for a net decline of 15 percent. The increase for 1983 appears to be related to a severe air stagnation episode occurring on February 28 and March 1, 1983.[12]

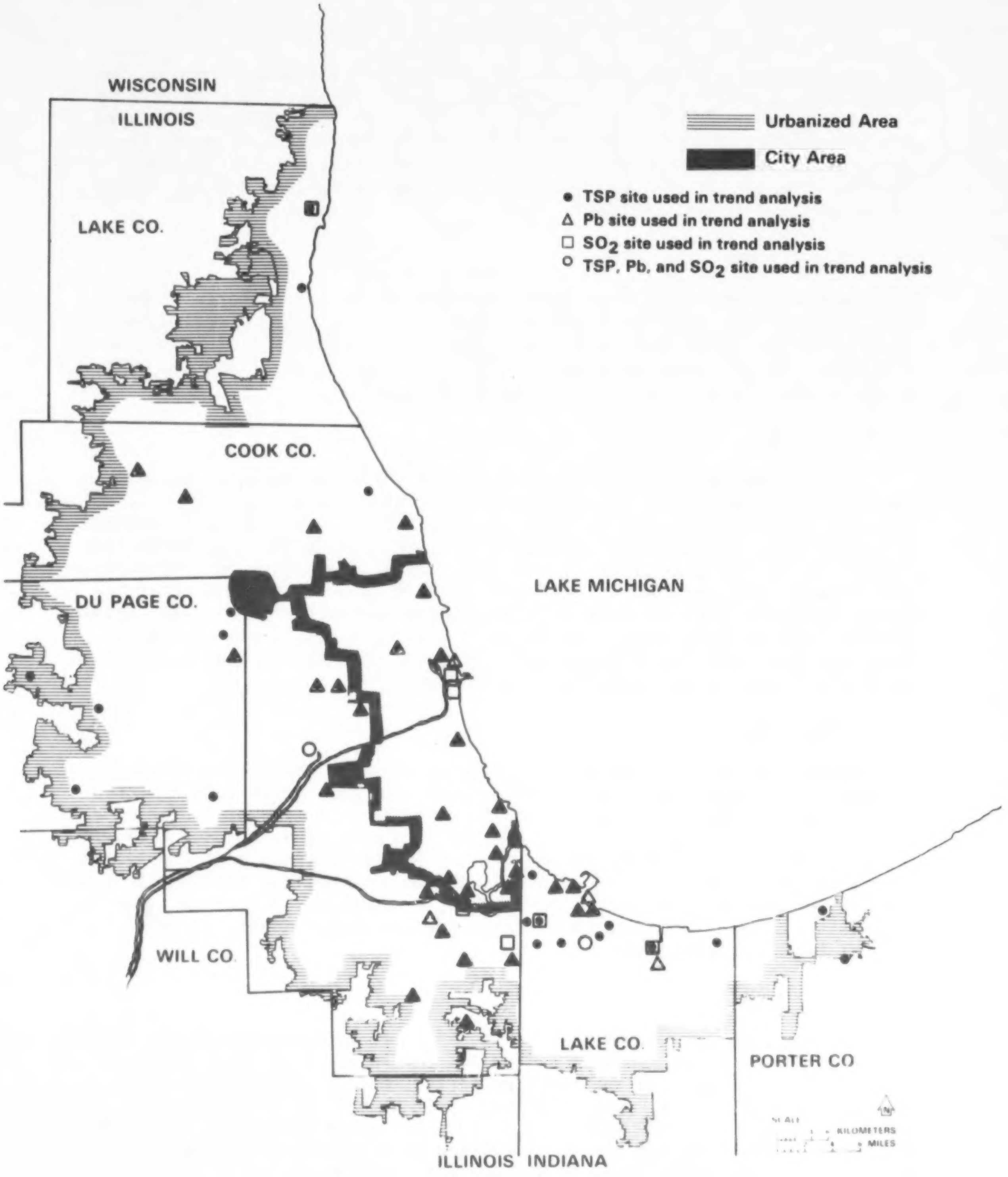

WISCONSIN
ILLINOIS
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
LAKE CO.
COOK CO.
LAKE MICHIGAN
DU PAGE CO.
WILL CO.
LAKE CO.
PORTER CO
N
SCALE
KILOMETERS
MILES
ILLINOIS
INDIANA

FIGURE 5-14. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN CHICAGO, IL-IN, 1980-1984.

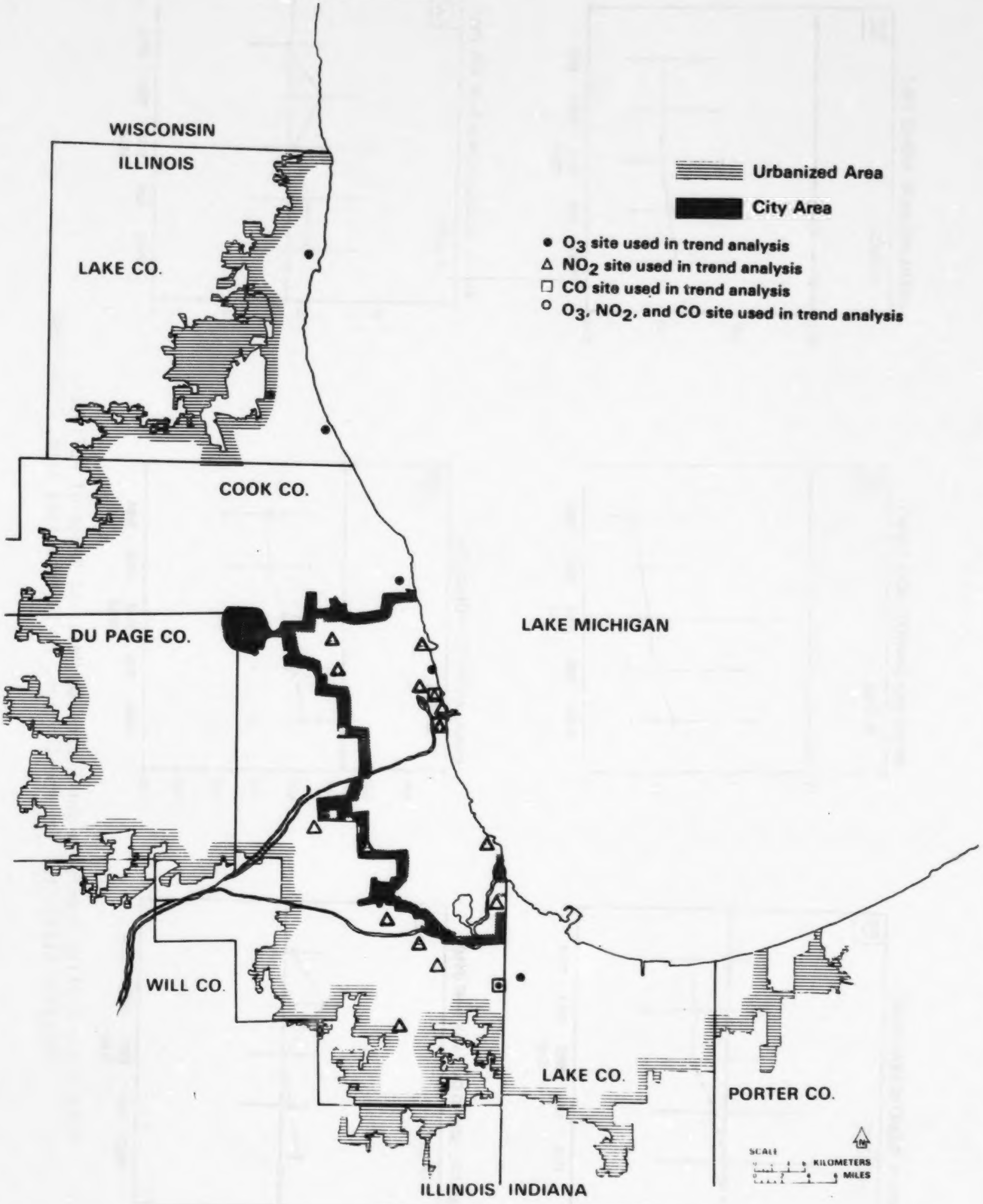
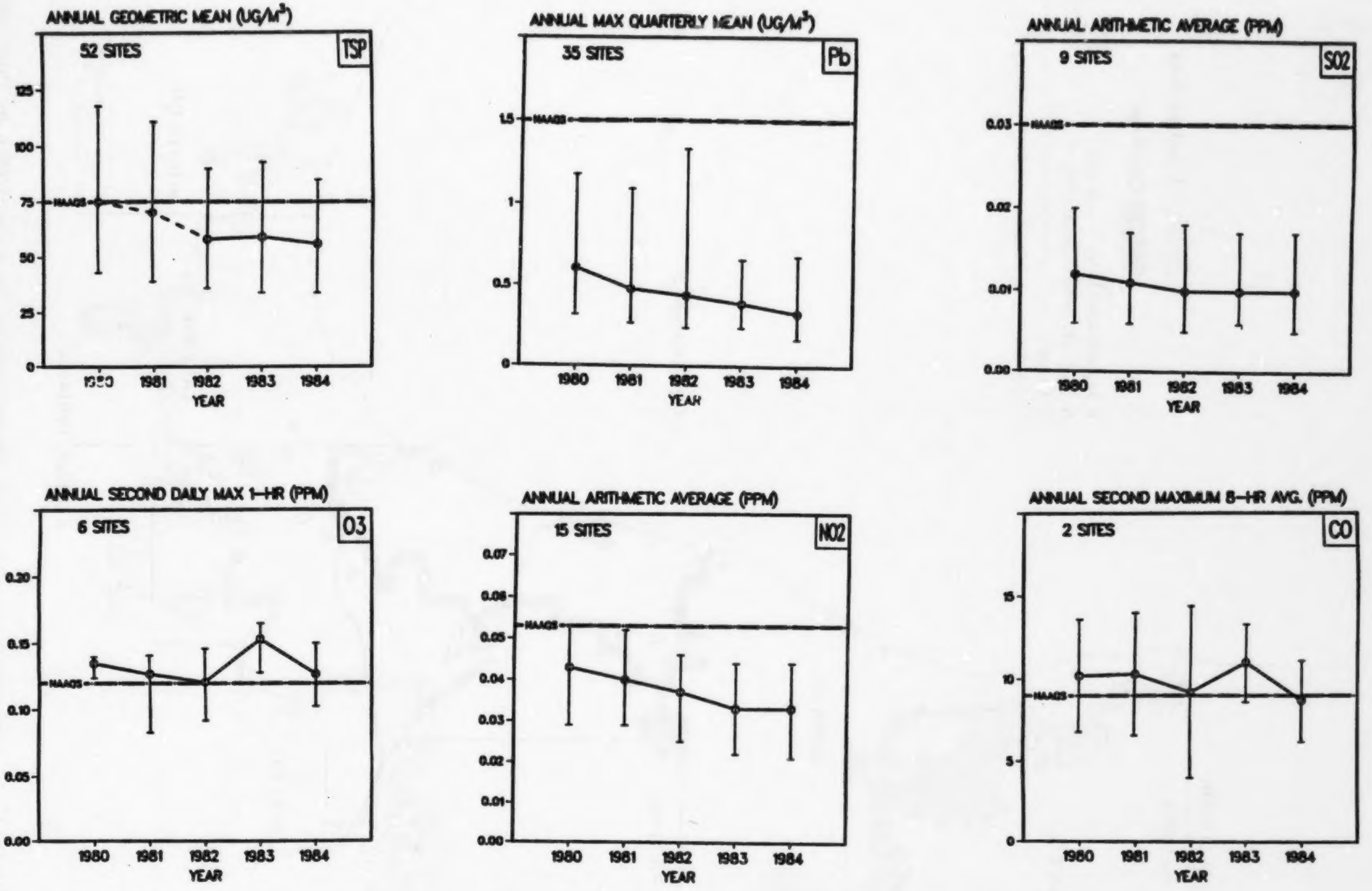

WISCONSIN
ILLINOIS
LAKE CO.
COOK CO.
DU PAGE CO.
WILL CO.
LAKE CO.
PORTER CO.
LAKE MICHIGAN
ILLINOIS INDIANA
▨ Urbanized Area
■ City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
SCALE
KILOMETERS
MILES
N

FIGURE 5-15. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN CHICAGO, IL-IN, 1980-1984.



5-16. Air Quality Trends in the Composite Mean and Range of Pollutant - Specific Statistics for the Chicago, IL-IN Urbanized Area, 1980-1984.

5.6 HOUSTON, TEXAS URBANIZED AREA

The Houston urbanized area is the tenth largest in the United States with a population of 2,412,664. It includes almost all of Harris County and very small portions of six other counties. The urbanized area extends about 55 miles east to west and 45 miles north to south and covers a total of approximately 750 square miles. The City of Houston has a population of 1,595,138 and is located west of Galveston Bay about 50 miles inland from the Gulf of Mexico.

Houston is a major seaport, particularly for petroleum products, and it has many refinery and petrochemical complexes along the Houston Ship Channel, which runs approximately 20 miles from the Houston center city east to Galveston Bay. The area is in the Sunbelt, has a mild climate moderated by the Gulf of Mexico, and is one of the fastest growing of all the major urbanized areas. The population has increased 44 percent since 1970.

Figure 5-17 shows the location of the TSP, Pb, and SO_2 sites used in the trend analysis. Figure 5-18 shows the location of the O_3, NO_2, and CO sites used in the trend analysis. Figure 5-19 shows the trends of the six pollutants during the study period.

5.6.1 TSP Trends

The Houston TSP trend was developed from 27 sites which met the data completeness criteria out of the 54 sites which operated during the period. Figure 5-17 shows the geographic distribution of the 27 sites which were used in the TSP trend analysis. The TSP trend in Houston is similar to the national trend with the first 2 years substantially higher than the last 3 years. The decrease is thought to be partially affected by a change in filters (see Section 3.1.1), and the 24 percent drop from the first to the last year is nearly identical with the 21 percent decrease found on a national basis.

5.6.2 Pb Trends

The Pb trend in Houston shows a 58 percent decrease compared to a 45 percent drop nationally for the 1980-1984 period. This trend is based on 18 sites which met the data completeness criteria. The data for these sites were obtained from the Houston Health Department.[13]

5.6.3 SO_2 Trends

The Houston SO_2 trend is based on 3 out of 13 sites which operated during the study period. SO_2 concentrations which are well below the NAAQS started and ended the 5-year period at the same level compared to the national trend which shows a 15 percent decrease between 1980 and 1984. Between 1980 and 1983, Houston showed a 10 percent decline in SO_2 levels followed by a 10 percent increase in 1984.

5.6.4 O_3 Trends

The pattern of the O_3 concentration in the Houston area is identical with the national average, 1980 and 1983 are high, while 1981, 1982 and 1984 are lower. Similar to the national trend, meteorology may have been more favorable for ozone buildup in 1983 than in 1981, 1982 and 1984. Nationally, between 1980 and 1984, there is a 9 percent decrease in O_3 levels. In contrast, 11 of the 16 monitoring sites in Houston, meeting the data completeness criteria, show a 25 percent decrease from 1980 to 1984.

5.6.5 NO_2 Trends

The Houston downward trend for NO_2 is almost three times greater than the national average, a 20 percent reduction versus an 7 percent reduction. This trend is based on 7 sites which met the data completeness criteria out of a total of 40 sites which monitored NO_2 in the Houston area during the 1980-1984 study period.

5.6.6 CO Trends

The Houston CO trend shows a 2 percent increase in contrast to the 10 percent drop in the national average. This increase is probably reflective of an increase in automobile traffic volume in the vicinity of the trend sites. This trend is based on only two of the nine CO monitoring locations which operated during the study period and which had enough data to meet the data completeness criteria.

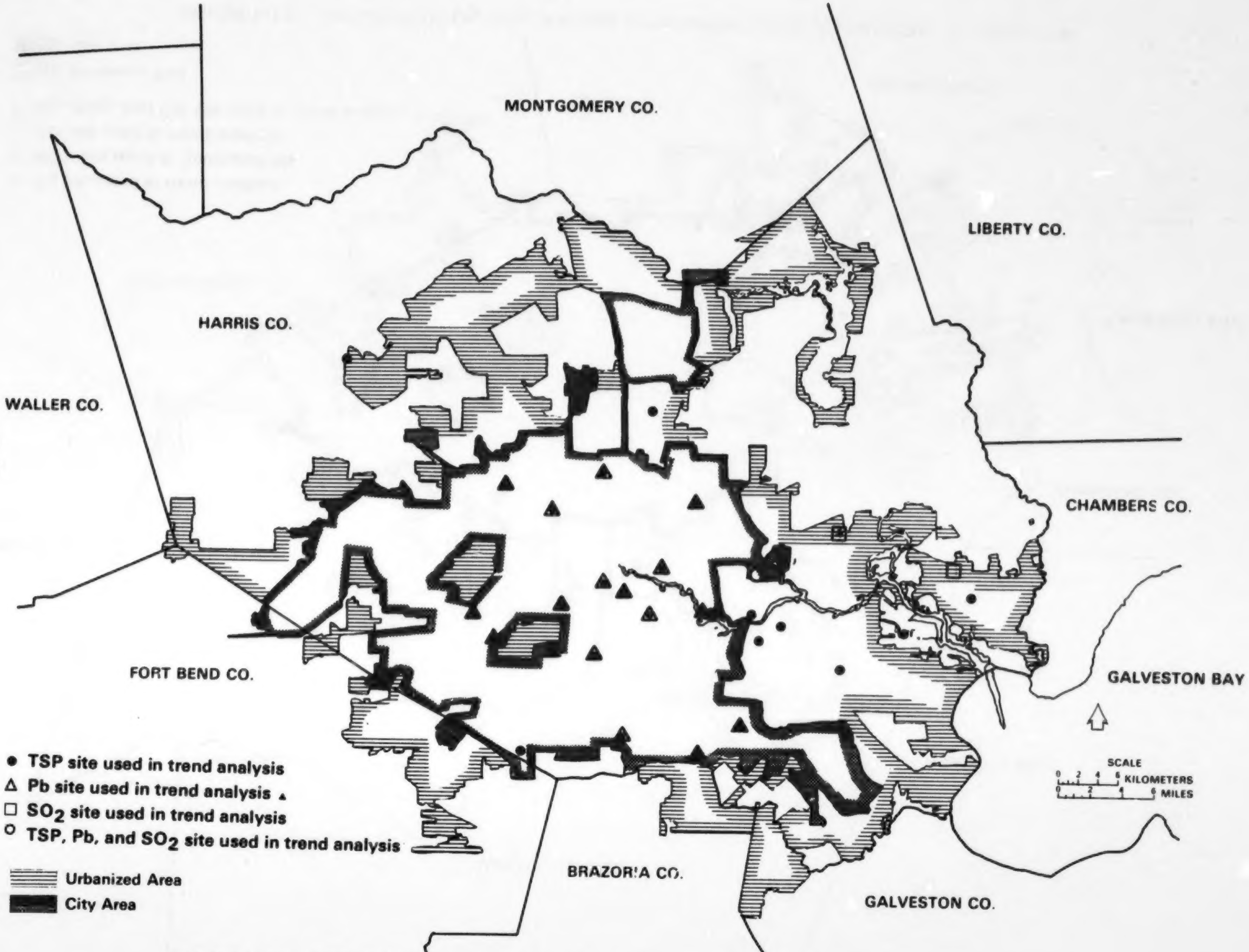

MONTGOMERY CO.
LIBERTY CO.
HARRIS CO.
WALLER CO.
CHAMBERS CO.
FORT BEND CO.
GALVESTON BAY
BRAZORIA CO.
GALVESTON CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
● TSP site used in trend analysis
△ Pb site used in trend analysis ▲
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
▤ Urbanized Area
■ City Area

FIGURE 5-17. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN HOUSTON, TX, 1980-1984.

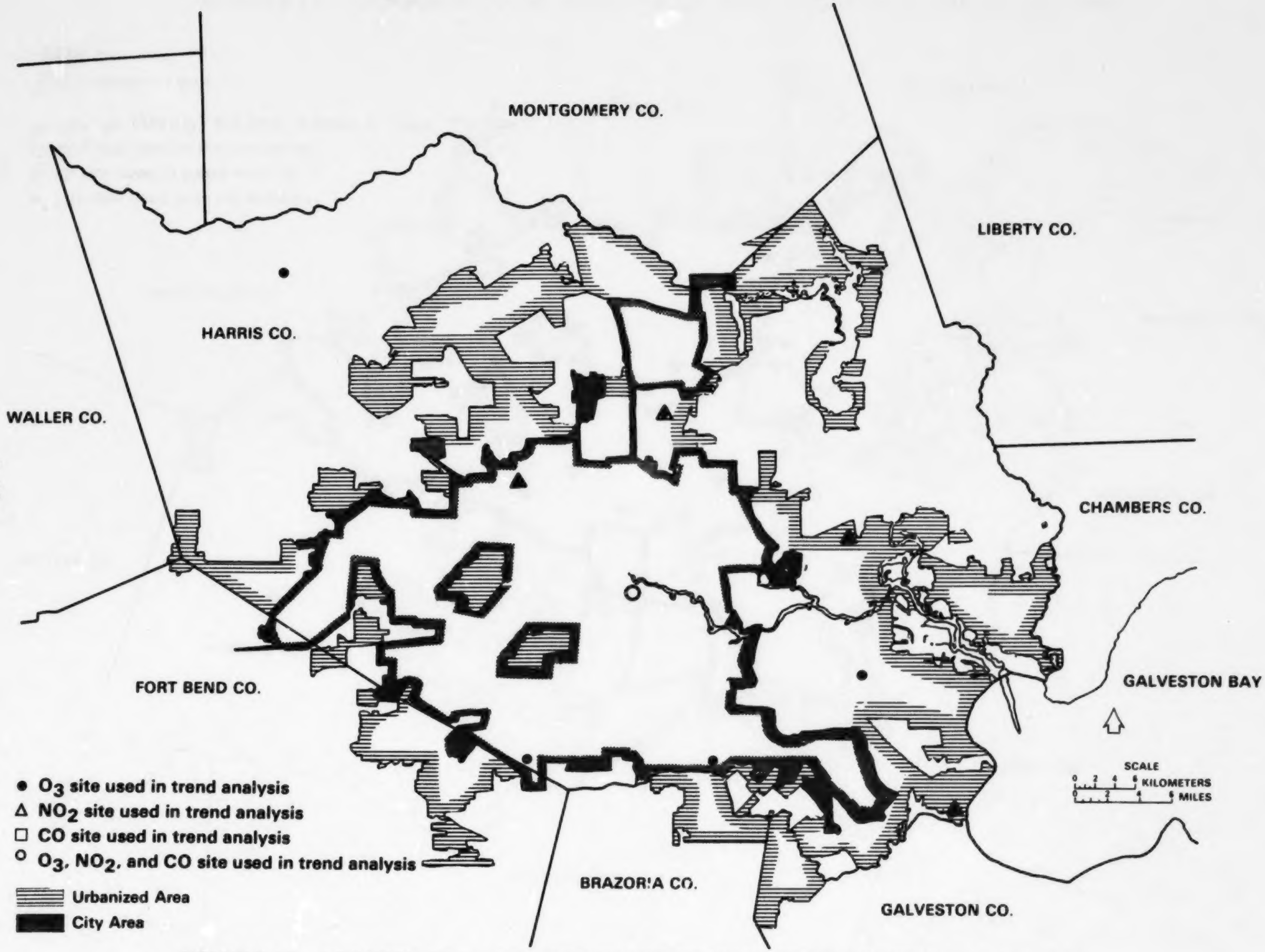

MONTGOMERY CO.
LIBERTY CO.
HARRIS CO.
WALLER CO.
CHAMBERS CO.
GALVESTON BAY
FORT BEND CO.
BRAZORIA CO.
GALVESTON CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
☐ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
▤ Urbanized Area
■ City Area

FIGURE 5-18. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN HOUSTON, TX, 1980-1984.

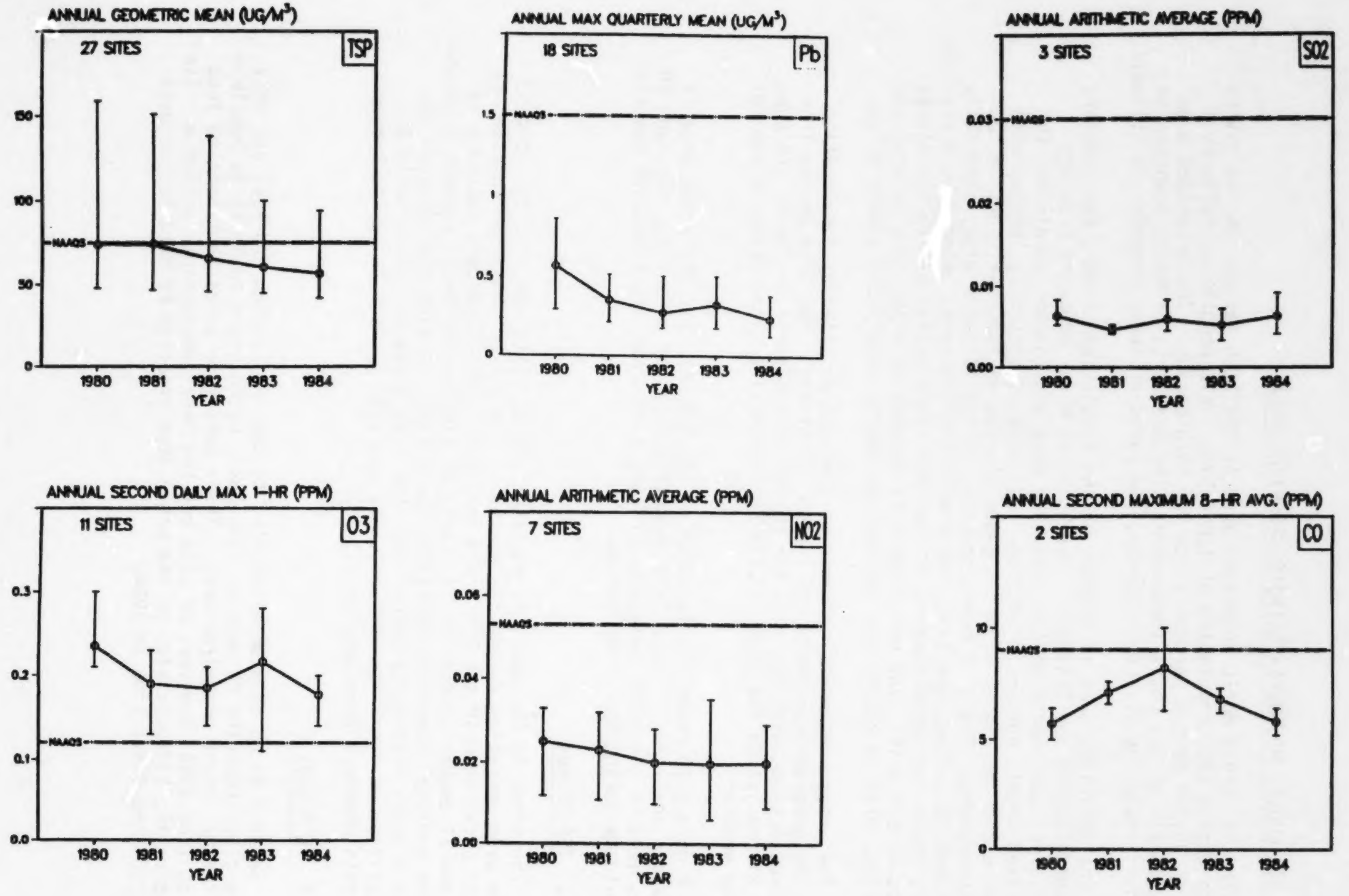


Figure 5-19. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Houston, TX Urbanized Area, 1980-1984.

5.7 ST. LOUIS, MISSOURI-ILLINOIS URBANIZED AREA

The St. Louis MO/IL urbanized area is the 11th largest in the United States with a 1980 population of 1,848,590. This population reflects a loss of 33,354 or 1.8 percent since the 1970 census. The urbanized area includes all of St. Louis Independent city and parts of three counties in Missouri including St. Louis County, and parts of three counties in Illinois.

The urbanized area is divided by the Mississippi River, the boundary between Missouri and Illinois. The Missouri River branches from the Mississippi just north of the urbanized area and further subdivides the urbanized area's northwest section. The area is centrally located with commerce and the distribution of goods playing an important part in the area's economy. There is heavy industry on the Illinois side, especially steel manufacturing, smelting, and chemical processing. Along the Misissippi River, there are large numbers of fuel burning electric generating plants. At its widest point, the urbanized area extends 48 miles east to west and 32 miles north to south, and encompasses approximately 509 square miles.

The areas continental climate is somewhat modified by its location near the geographical center of the United States. The area enjoys four distinct seasons with the cold air masses to the North in Canada and the warm air masses to the South in the Gulf of Mexico alternating in control of the weather.

Figure 5-20 shows the location of the TSP, Pb, and SO_2 sites used in the trend analysis. Figure 5-21 shows the location of the O_3, NO_2, and CO sites used in the trend anslysis. Figure 5-22 shows the trends of the six pollutants during the study period.

5.7.1 TSP Trends

The trend in St. Louis is derived from 22 sites out of a possible 33 which were operating during the period. Figure 5-20 shows the location of the 22 sites used in the TSP trend analyses. The 24 percent decrease in the annual geometric mean in St. Louis is similar to the 21 percent decrease in the national composite average. The pattern is also similar with the first 2 years distinctly higher than the last 3 years. A change in the composition of the filter between 1981 and 1982 is felt to be the reason for this decrease (see Section 3.1.1).

5.7.2 Pb Trends

Because no Pb data were reported to the EPA in 1980 and 1981 and only three sites reported Pb data in 1982-1984, no Pb trend analysis is possible for the St. Louis urbanized area. There were four sites that sampled lead during 1980-1984; however, no site met the data completeness criteria. Six sites on the Illinois side of the urban area reported Pb data to the Data bank for the first time in 1984.

5.7.3 SO_2 Trends

The trend in annual average SO_2 in St. Louis shows a 7 percent increase over the period 1980-1984, while the national composite average has dropped 15 percent during the same period. The increase in St. Louis is believed to be attributed to a general economic recovery in the area. The trend in St. Louis is based on 8 out of a possible 17 sites operating during 1980-1984.

5.7.4 O_3 Trends

The St. Louis O_3 trend is based on 10 of 22 sites which operated during the 1980-1984 period. These sites showed a 1 percent decrease between 1980 and 1984. The pattern over the 5-year period is similar to the national trends, that is, high levels in 1980 and 1983 and lower levels in 1981 and 1982. Although 1984 levels were almost as high as 1980 levels, there was a 6 percent decrease from 1983 to 1984 which is similar to the national 1983-1984 decrease of 9 percent. As with many sections of the rest of the country, meteorological conditions may have been more favorable for ozone formation in 1983 than in 1981 and 1982.

5.7.5 NO_2 Trends

The 21 percent decrease in the NO_2 trend is three times greater than the 7 percent decrease on a national basis. This trend is based on only 5 out of 16 possible site locations meeting the data completeness criteria required for inclusion in the trend analysis.

5.7.6 CO Trends

The trend in the St. Louis urbanized area is based on 5 of 14 sites which had sufficient data to meet the criteria for trend analysis. The 6 percent decrease in the CO trend is comparable with the national 10 percent decrease during the study period. This smaller decrease could be attributed to the general economic recovery of the area even though there was a small population loss in the urbanized area over the previous 10 years.

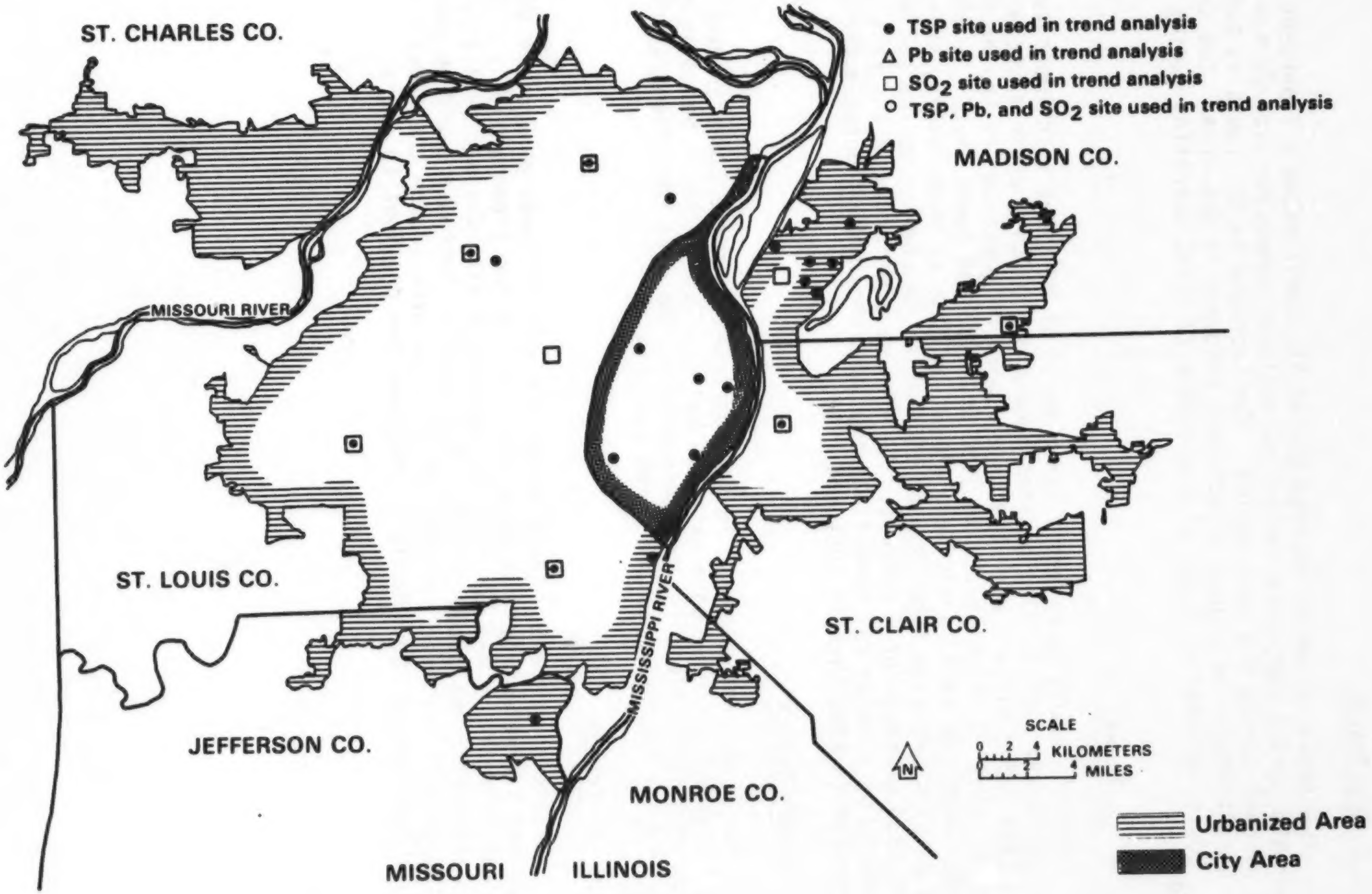

ST. CHARLES CO.
● TSP site used in trend analysis
△ Pb site used in trend analysis
☐ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis
MADISON CO.
MISSOURI RIVER
ST. LOUIS CO.
ST. CLAIR CO.
MISSISSIPPI RIVER
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N
JEFFERSON CO.
MONROE CO.
MISSOURI
ILLINOIS
▤ Urbanized Area
■ City Area

FIGURE 5-20. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN ST. LOUIS, MO-IL, 1980-1984.

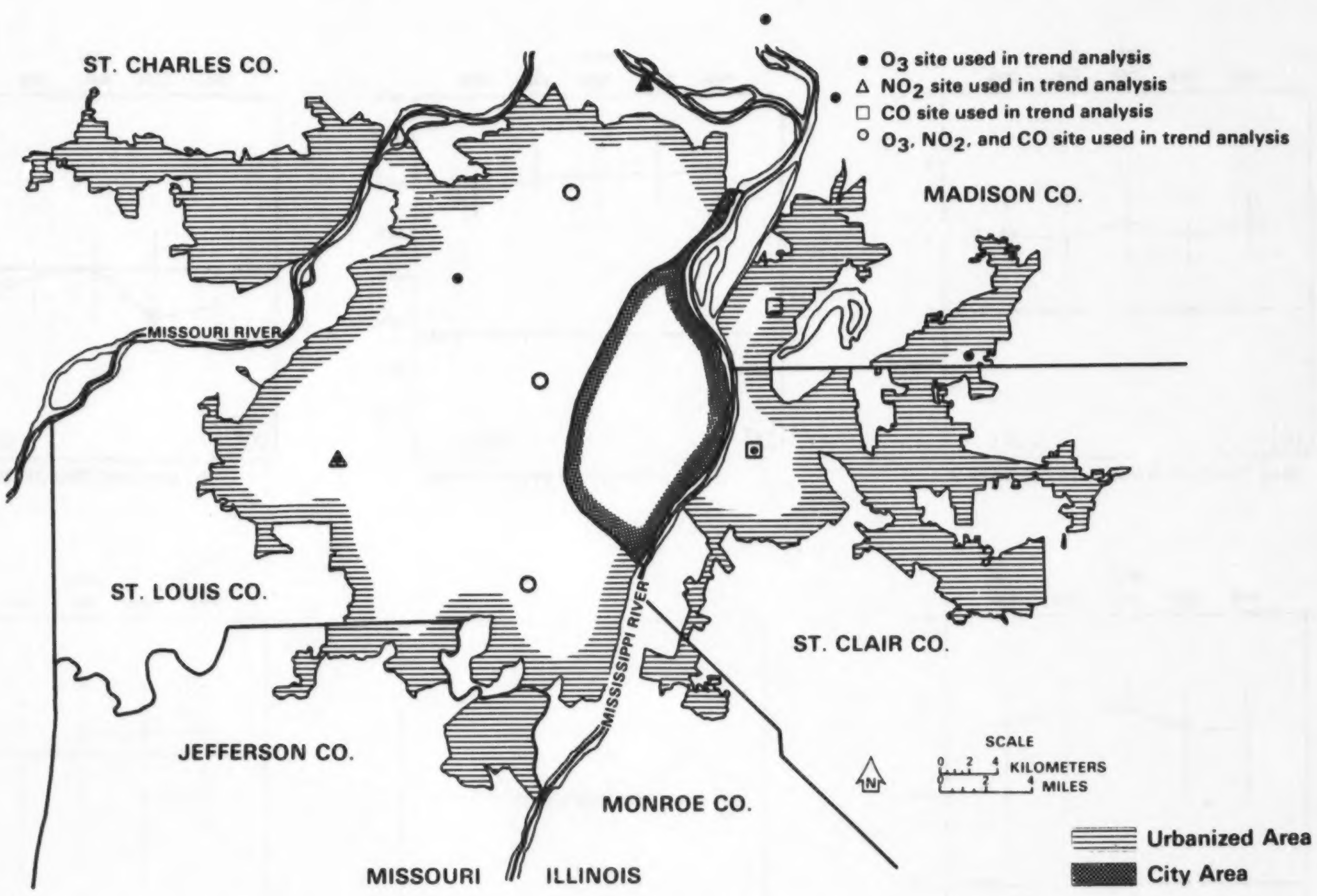

ST. CHARLES CO.
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
MADISON CO.
MISSOURI RIVER
ST. LOUIS CO.
ST. CLAIR CO.
MISSISSIPPI RIVER
JEFFERSON CO.
SCALE
0 2 4 KILOMETERS
0 2 4 MILES
N
MONROE CO.
Urbanized Area
City Area
MISSOURI
ILLINOIS

FIGURE 5-21. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN ST. LOUIS, MO-IL, 1980-1984.

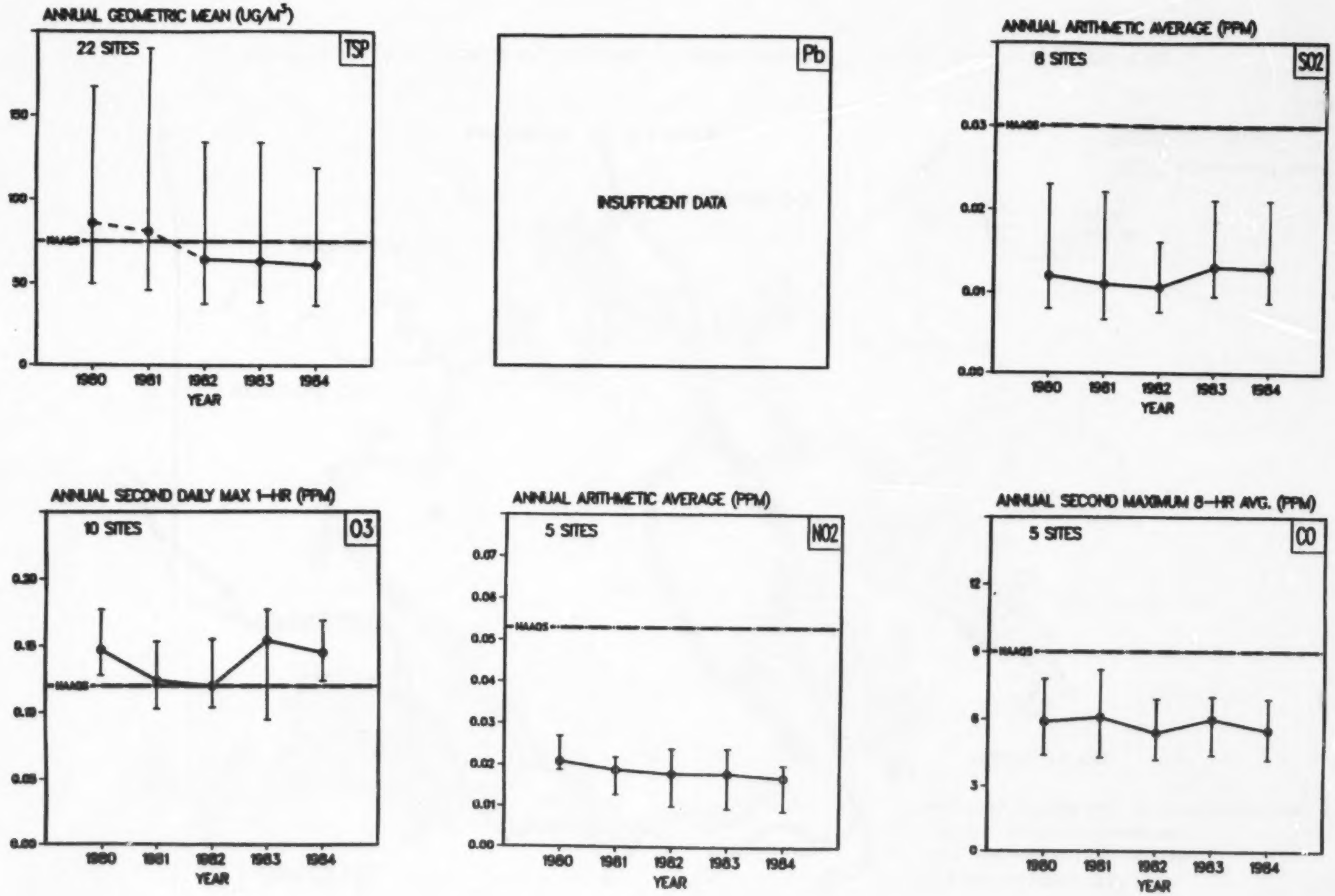


Figure 5-22. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the St. Louis, MO-IL Urbanized Area, 1980-1984.

5.8 DENVER, COLORADO URBANIZED AREA

The Denver urbanized area had a 1980 population of 1,352,070 and includes all of Denver County plus portions of Adams, Arapahoe, Boulder, Douglas, and Jefferson Counties. At the maximum boundaries, the urbanized area extends about 27 miles east to west and 26 miles north to south.

Denver, the capital of Colorado, is located at the western edge of the great plains of the Midwest. The Rocky Mountains are just to the west of the urbanized area. Denver is one of the highest cities in the United States with an altitude of about 1 mile above sea level.

Although manufacturing is minimal compared to other cities of similar populations, Denver does have manufacturing industries for rubber goods and luggage. Other industries include food processing, milling, printing and publishing, steel processing, machinery manufacture, and power generation. Denver has a large stockyard and has the largest sheep market in the United States. In recent years, many energy concerns have located their headquarters in Denver.

The meteorology in Denver is unique in that air masses from at least four different sources influence the weather in the urbanized area. These sources are polar air from Canada and the far northwest, moist air from the Gulf of Mexico, warm dry air from Mexico and the southwest, and Pacific air modified by the passage overland. Since Denver is a long distance from any moisture source and is separated from the Pacific source by high mountains, Denver generally has low relative humidity and low average precipitation of around 14 inches per year.

Figure 5-23 and 5-24 show the locations of the monitors used in the trend analysis, and Figure 5-25 show the trend graphs for the pollutants.

5.8.1 TSP Trends

Fifteen sites sampled TSP in the urbanized area during 1980-1984 and 12 of these sites met the data completeness criteria and were used in the trend analysis. Figure 5-16 shows the location of the 12 samplers used fo the trend. Figure 5-17 shows a plot of the trends for 1980-1984 in which the composite average decreased 11 percent compared to the national decrease of 21 percent for the same period. Some of the decrease between 1981 and 1982 has been attributed to the filters used for collecting the samples (see Section 3.1.1). The TSP composite average was above the NAAQS for each year during 1980-1984. The elevated TSP levels in Denver have been attributed to the arid conditions and reentrainment of dust particles.

5.8.2 Pb Trends

There were ten sites in the urbanized area which sampled Pb during 1980-1984 and four sites met the data completeness criteria. The trend from 1980 to 1984 in Denver decreased 38 percent compared to the national decline of 45 percent. The composite average of the four sites in Denver is about twice as high as the national composite. This, like TSP measurements, are believed to be caused in part by low rainfall conditions cited previously resulting in more reentrainment of Pb particles in street dust.

5.8.3 SO_2 Trends

The SO_2 trends for the urbanized area were developed from two sites out of the three sites which had data during 1980-1984. The trends for the composite average show fluctuations with a decrease of 10 percent during the period. The composite averages are about one-third of the NAAQS.

5.8.4 O_3 Trends

Five sites out of seven sites met completeness criteria and were used in the trend analysis. The composite average for the five sites increased each year during 1980-1983 followed by a decrease in 1984. The composite average decreased 4 percent during 1980-1984 as compared to the national average which decreased 9 percent.

5.8.5 NO_2 Trends

There were three sites that reported NO_2 data during 1980-1984, and all three sites were used in the trend analysis. The composite average decreased slightly from 1980-1982, increased in 1983, and decreased in 1984. The composite average was the same in 1980 and 1984 as compared to the national decline of 7 percent. The concentrations measured at a site in downtown Denver continue to be among the highest in the nation due to mobile and point sources.

5.8.6 CO Trends

The CO concentrations were measured at ten sites in the urbanized area and four of these sites met the data completeness criteria and were used for the trend analysis. The composite average showed an increase of 3 percent from 1980 to 1984. The use of wood for home heating in air tight stoves in recent years could contribute up to 10 percent of the measured CO concentrations.[14] The national composite average decreased 10 percent for the same period. The composite average for each year was above the NAAQS.

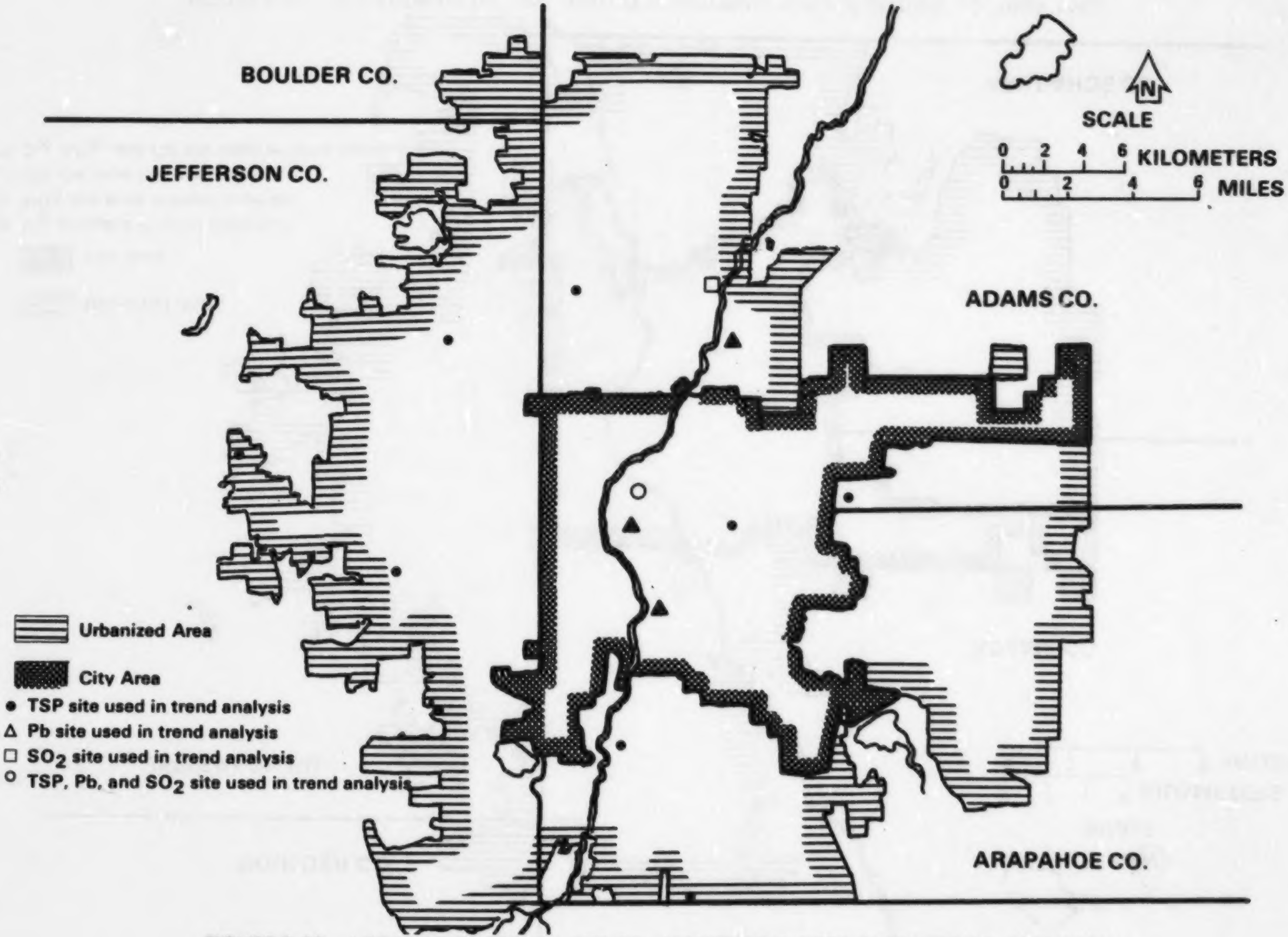

BOULDER CO.
JEFFERSON CO.
ADAMS CO.
ARAPAHOE CO.
N
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO_2 site used in trend analysis
○ TSP, Pb, and SO_2 site used in trend analysis

FIGURE 5-23. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN DENVER CO, 1980-1984.

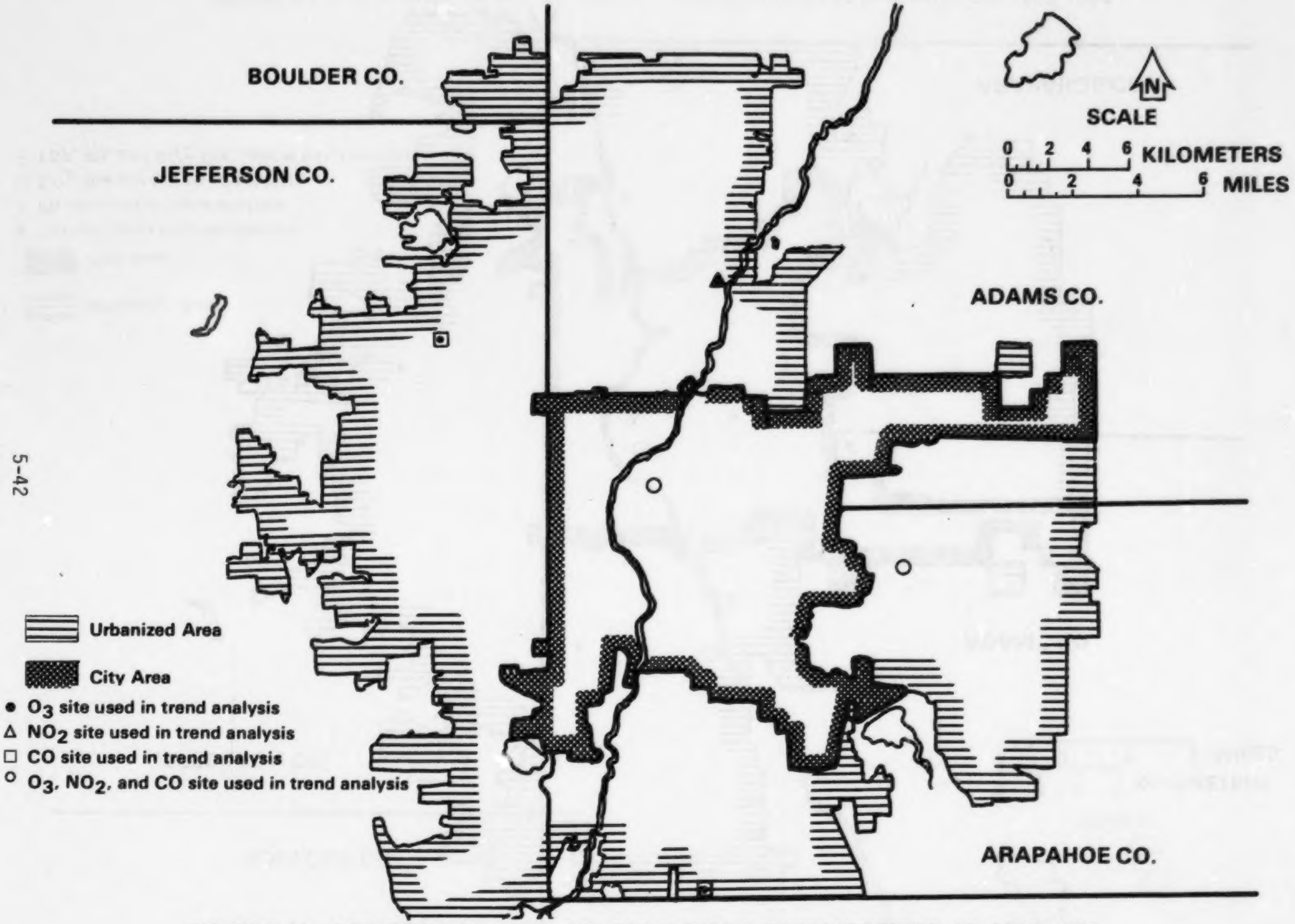

BOULDER CO.
JEFFERSON CO.
ADAMS CO.
ARAPAHOE CO.
N
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
Urbanized Area
City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis

FIGURE 5-24. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN DENVER, CO, 1980- 1984.

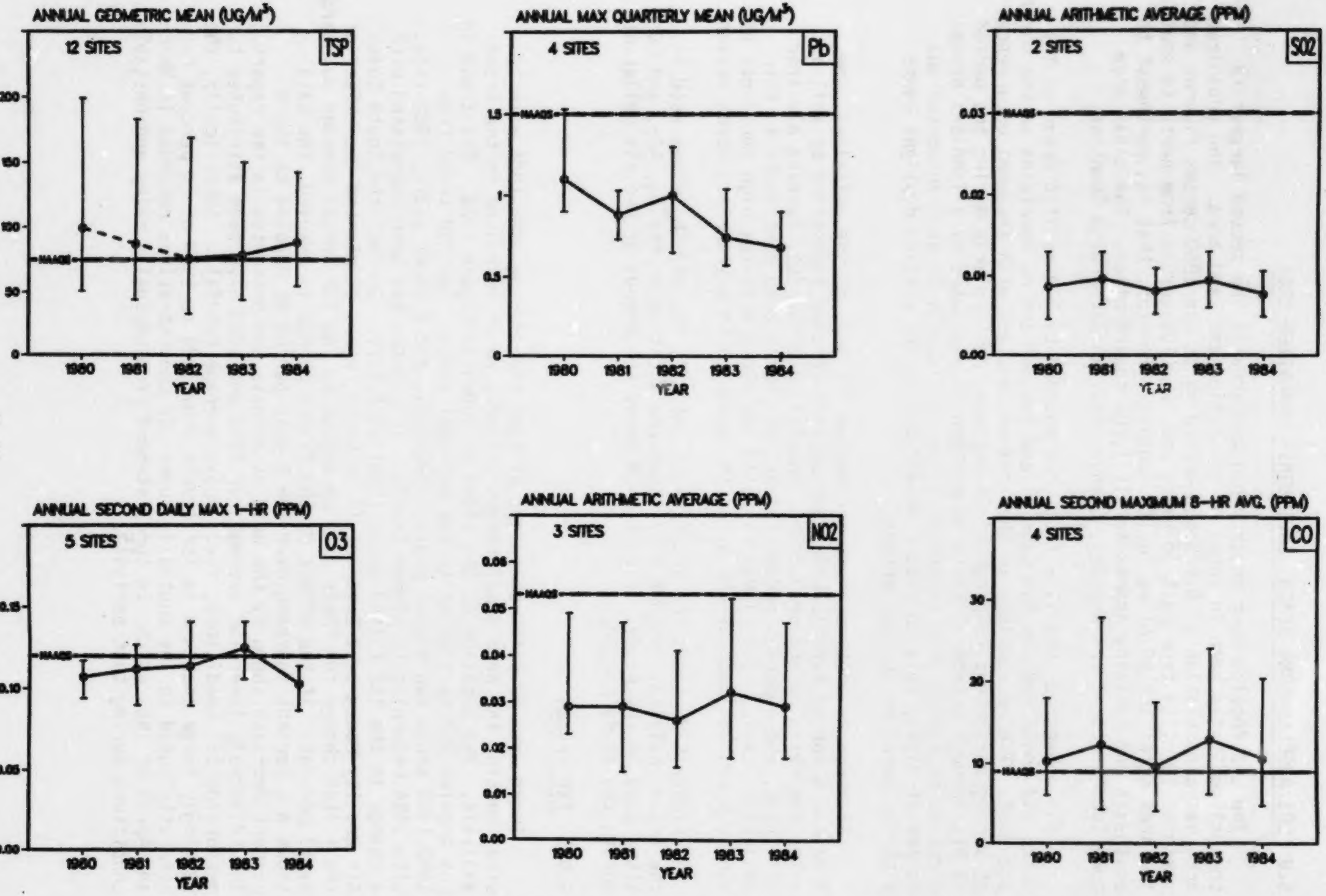


Figure 5-25. Air Quality Trends in the Composite Mean and Range of Pollutant - Specific Statistics for the Denver, CO Urbanized Area, 1980-1984.

5.9 LOS ANGELES-LONG BEACH, CALIFORNIA URBANIZED AREA

The Los Angeles-Long Beach urbanized area is the second largest in the United States both in terms of population and land area. The urbanized area has a population of 9,479,436 according to the 1980 census figures and measures 70 miles from east to west, and 71 miles across from north to south. The area stretches 90 miles in its longest dimension, that is, northwest to southeast and contains approximately 1,700 square miles. The urban area comprises parts of Los Angeles, Orange, and San Bernardino Counties.

The urbanized area is a flat area bounded by the Pacific Ocean on the west, and south and the San Gabriel and San Bernardino Mountains on the north and east. The meteorology in the area is complex, with frequent occurrences of strong persistent temperature inversions, particularly during the period of May through October. The wind pattern is dominated by a land-sea breeze circulation system that sometimes allows pollutants to be transported out to sea at night, only to return inland during the ensuing daylight hours with the onset of the sea breeze.

Although automotive sources comprise the bulk of the emissions, the area has a lot of manufacturing and service related industries as well as petroleum refining and production, chemical plants, fuel burning electric utilities, and numerous industrial boilers which also contribute to the pollution levels. The climate is mild and along with the high incidence of sunlight and latitude of the area, is conducive to a year-long ozone season.

Figure 5-26 shows the location of the TSP, Pb, and SO_2 sites used in the trend analysis. Figure 5-27 shows the location of the O_3, NO_2, and CO sites used in the study. Figure 5-28 shows the trends of the six pollutants during the study period.

5.9.1 TSP Trends

There were 22 sites operating at some time during 1980-1984 with 12 sites meeting the data completeness criteria which were used in the trend analysis. The location of the sites is shown in Figure 5-26. The trend in Los Angeles TSP is similar to the national trend. The TSP trend from 1980-1984 shows two higher years, 1980-1981, and 2 lower years, 1982-1983, with 1984 returning to higher levels. This trend has been associated with a change in the TSP filter media (Section 3.1.1). In fact the South Coast Air Quality Management District[15] in their report eliminated the effect of the filter change for their data by adjusting the TSP annual average downward by 13 percent. If the effect of the filter change is removed, the data shows a 5 percent increase over the 5-year period as opposed to the 9 percent decrease shown by the unadjusted data and presented in the report. The relatively lower TSP averages in 1982 and 1983 have been attributed to meteorological conditions, i.e., above average rainfall. Specifically, the seemingly large increase in TSP levels from 1983 to 1984 of 21 percent has been attributed to the unusually lower TSP concentrations recorded in March and April of 1983 which, in turn, stemmed from unusually rainy and unstable conditions during that period[15].

5.9.2 Pb Trends

Los Angeles, with its preponderance of automotive related pollution, exceeded the national average of 45 percent reduction in Pb levels with a 60 percent drop of its own. This is based on 12 of the 20 sites which met the data completeness criteria during 1980-1983. California has a more stringent lead standard than the NAAQS, and both of these standards were met for all sampling sites for the first time in 1983 and continued to be met in 1984.

5.9.3 SO_2 Trends

The drop in Los Angeles of 25 percent in annual average SO_2 levels is well ahead of the 15 percent decline seen nationally. This trend is made up of 15 monitors which met data completeness criteria of the 23 monitors which operated during the period. The increased improvement is attributed to having cleaner fuels and a major point source, a steel facility, shutting down during the period.

5.9.4 O_3 Trends

The O_3 trend in Los Angeles closely parallels the national 9 percent reduction with an average drop of 11 percent over the 5-year period. The trend is based on 18 of 25 sites which operated during this period. A recent trend analysis conducted by the South Coast Air Quality Management District indicates that 1982 was a year of record low meteorological ozone forming potential, and that 1983 was a return to near normal meteorological conditions.[16] An update of the analysis indicates that while 1984 had even higher meteorological potential for ozone formation than 1983[15], the 11 percent decrease in 1984 may be partially due to efforts to reduce congestion during the Olympic period which resulted in an estimated weather-adjusted average reduction of 12 percent in basinwide ozone maxima.[17]

5.9.5 NO_2 Trends

Of the 21 sites operating in the Los Angeles area, 15 met the trends criteria and were used in the analysis. The Los Angeles NO_2 levels decreased 10 percent, compared with an 7 percent reduction for the nation.

5.9.6 CO Trends

The decrease in the CO levels is 34 percent or slightly over three times the national average of 10 percent. This trend is comprised of 16 of the 20 sites operating during the 1980-1984 period. The percentage reduction is thought to be greater than the national average because of the higher automotive related pollution in Los Angeles relative to the rest of the nation, and the stringency of their automotive control program.

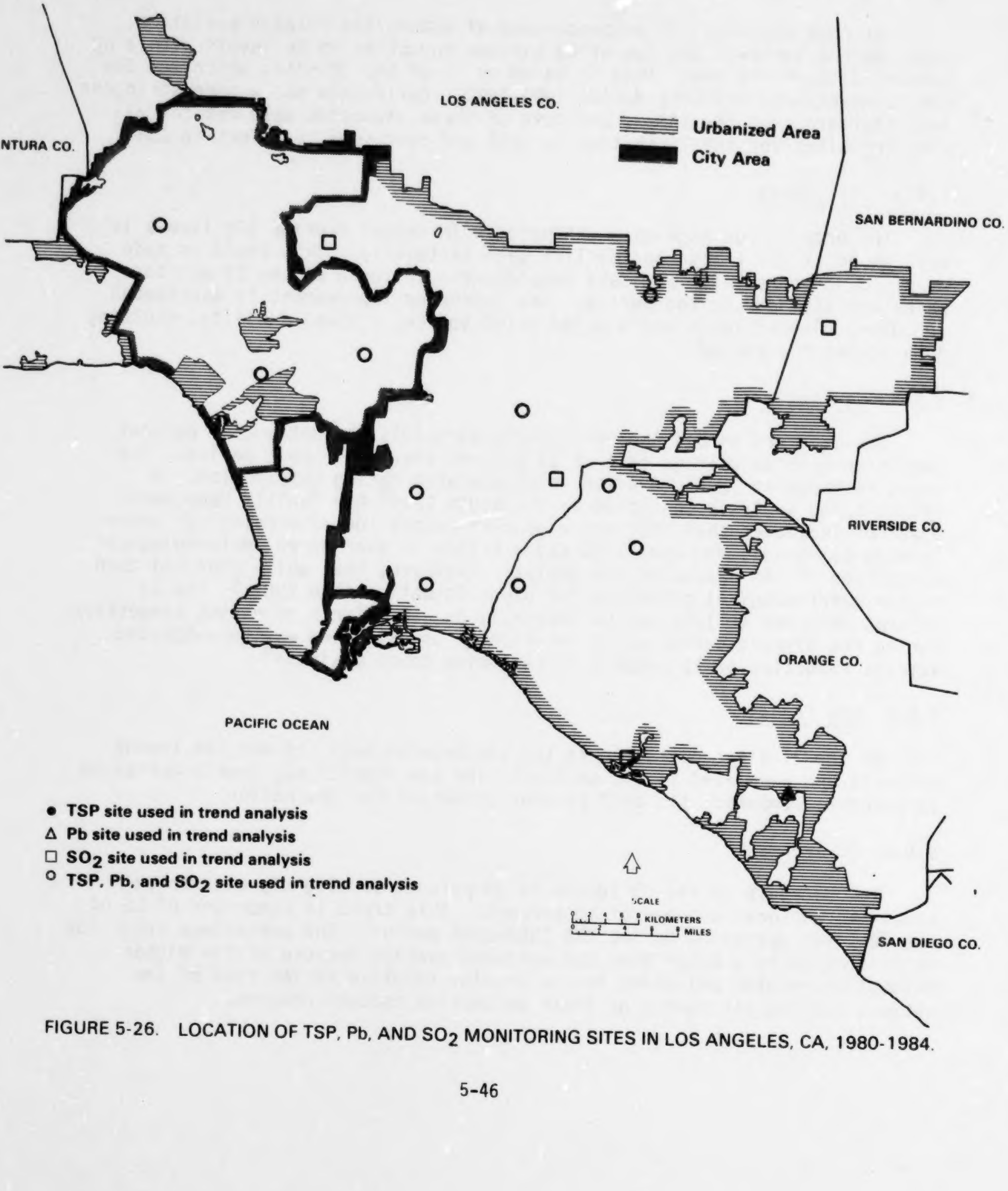

LOS ANGELES CO.
NTURA CO.
Urbanized Area
City Area
SAN BERNARDINO CO.
RIVERSIDE CO.
ORANGE CO.
PACIFIC OCEAN
SAN DIEGO CO.
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO₂ site used in trend analysis
○ TSP, Pb, and SO₂ site used in trend analysis
SCALE
KILOMETERS
MILES

FIGURE 5-26. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN LOS ANGELES, CA, 1980-1984.

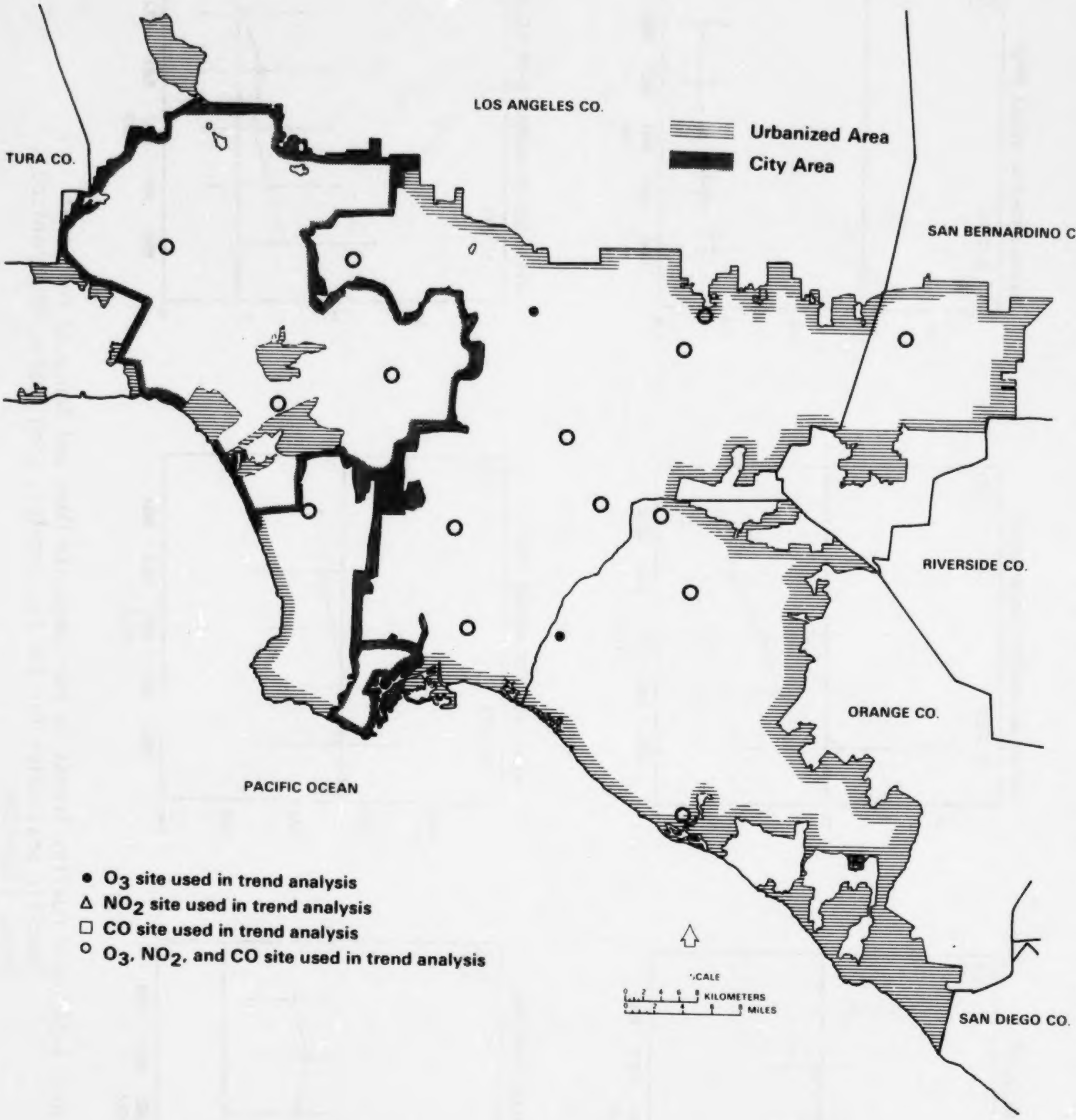

LOS ANGELES CO.
Urbanized Area
City Area
TURA CO.
SAN BERNARDINO CO.
RIVERSIDE CO.
ORANGE CO.
PACIFIC OCEAN
SAN DIEGO CO.
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
SCALE
0 2 4 6 8 KILOMETERS
0 2 4 6 8 MILES

FIGURE 5-27. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN LOS ANGELES, CA, 1980-1984.

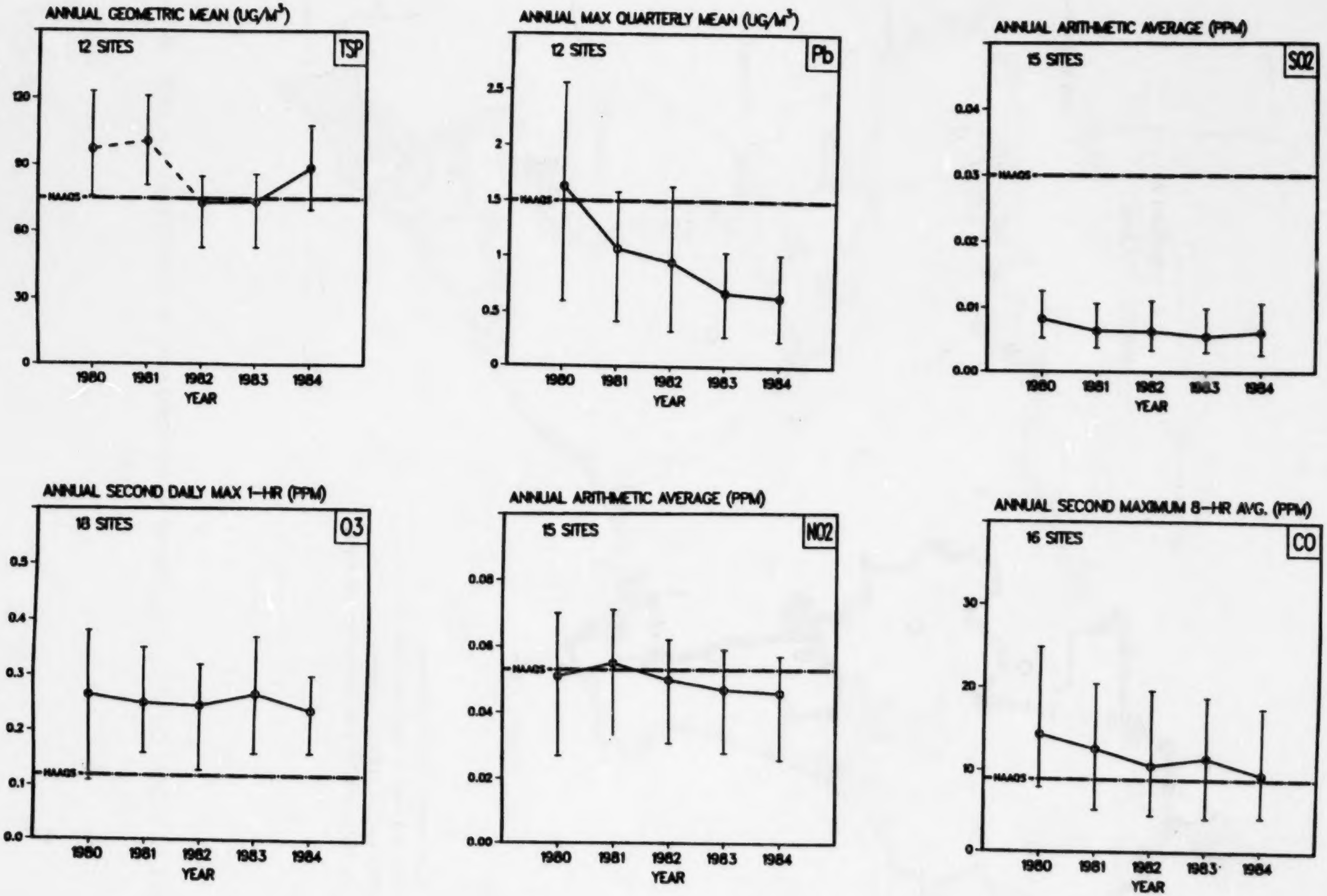


Figure 5-23. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Los Angeles, Long Beach, CA Urbanized Area, 1980-1984.

5.10 PORTLAND, OREGON-WASHINGTON URBANIZED AREA

The Portland urbanized area covers approximately 300 square miles and includes over 1,020,000 people. Approximately 50 percent of the urbanized area population live in Multnomah County, the remaining 50 percent live in parts of Clackamas and Washington Counties in Oregon and part of Clark County, Washington.

The urbanized area is roughly bounded by Hazel Dell and Orchards in Washington to the north; Forest Grove, Oregon to the west; Troutdale and Gresham to the east; and Beaver Creek to the south.

Until the 1940's, Portland was largely a commercial and transportation center. With the introduction of relatively cheap hydroelectric power in the 1940's, metallurgical and chemical industries augmented the ongoing commerce of the area.

The Portland area is about 65 miles from the Pacific Ocean and is partially shielded from the maritime climate of the Pacific Ocean by the surrounding hills and mountains. The winds are generally southeasterly during the winter and northwesterly during summer. The average precipitation for the area is 37 inches and typically 88 percent of the rainfall occurs in the months of October through May.

The locations of the TSP, Pb, and SO_2 sites used in the trend analysis are shown in Figure 5-29, and the locations for O_3, NO_2, and CO sites are shown in Figure 5-30. The trend graphs for all pollutants are shown in Figure 5-31.

5.10.1 TSP Trends

Figure 5-29 is a map showing the approximate location of the 15 TSP sampling locations operated in the Portland urbanized area during the period between 1980 and 1984 and met the trends criteria. During the period 1980 to 1984, 20 TSP sampling sites operated in the Portland area, and 15 of these sites met the trend criteria and were used in the trend graphs for Portland (Figure 5-31). The composite average has declined over the 5-year period by approximately 34 percent which is nearly twice the national decline of 21 percent for TSP. This has occurred because TSP values in Portland during 1980 were greatly elevated due to the fallout from the Mt. St. Helens volcanic eruption. If the 1980 TSP composite average is ignored, the decline in TSP concentrations for 1981 through 1984 is approximately 6 percent or about one-half the national decline for the period 1981-1984. Also, some of the decrease between 1981 and 1982 may have been caused by a change in the filters (Section 3.1.1).

5.10.2 Pb Trends

The Pb data for the Portland area trend analysis includes the SAROAD data base and Pb data from the 1984 Oregon Air Quality Annual Report produced by the State of Oregon.[18] Figure 5-31 shows the composite average of maximum quarterly concentrations of Pb from the 6 of 14 sites which met the 4-year trend criteria. The location of these 6 sites is shown on Figure 5-29. The composite average for Pb in Portland has declined by 53 percent during the period compared to the national rate of 45 percent. This difference may be attributed to a State regulation which prohibits the customer from pumping his own gasoline resulting in a lower rate of fuel switching.

5.10.3 SO_2 Trends

The SO_2 trend sites for Portland are shown on Figure 5-29. The composite annual average for SO_2 represents the two of four SO_2 monitoring sites in the Portland area with sufficient data to meet the data criteria for the period 1981-1984. No site operating during 1980 met the trend criteria; therefore, no value for 1980 SO_2 has been shown on Figure 5-31. During the period 1981 to 1983, the SO_2 levels at these sites declined by 20 percent or about 5 percent more than the national decline of 15 percent. Large point sources of SO_2 emissions are absent in the Portland area and this is reflected in Portland annual average concentrations of SO_2 which are less than one third of the SO_2 NAAQS.

5.10.4 O_3 Trends

The composite average for O_3 for the Portland area is based on all three of the sites operated during the period between 1980 and 1984. The composite average for the area increased in 1981 over 1980 then declined from 1982 through 1984 for a net increase of 11 percent between 1980 and 1983. This is a different pattern from the national trend for ozone which has shown a decline in average concentrations from 1980 through 1982 with a pronounced increase in 1983. The reasons for Portland's departure from the national pattern appear to be related to the local meteorology. Generally, the high maximum O_3 value trends correspond to the trend in the number of air stagnation days during the spring and summer months. This decrease may also be due in part to a lower rate of fuel switching due to the State law prohibiting customers from pumping their own gas.

5.10.5 NO_2 Trends

The Portland urbanized area was not large enough at the time of the 1970 census to require NAMS NO_2 monitoring. However, there have been studies at two NO_2 sites which were operated for a short period of time during 1980 and 1981. Although neither of the sites met the trend criteria and no trend lines for NO_2 could be prepared, it appears that the NO_2 averages which are about 30 to 50 percent of the NAAQS have remained stable since 1980.

5.10.6 CO Trends

The CO trend for Portland shown on Figure 5-31 is for the five of six sites which met the trends criteria for the 1980 through 1984 period. These sites are shown on Figure 5-30. The composite average declined by 17 percent between 1980 and 1982, then showed a 12 percent increase for 1983 over 1982 and then declined again in 1984 for an overall decline of 27 percent over the period 1980-1984. The reduction of CO levels in Portland is more than twice the national rate of 10 percent which may be attributed to the State's CO control program. This is different than the national trend which showed a decline for each of the years in the 5-year period. The increase in CO concentrations during 1983 may in large part be attributable to the temporary displacement of significant traffic volumes off Interstate 84 onto other surface and arterial street systems, elevating levels measured at affected sites.

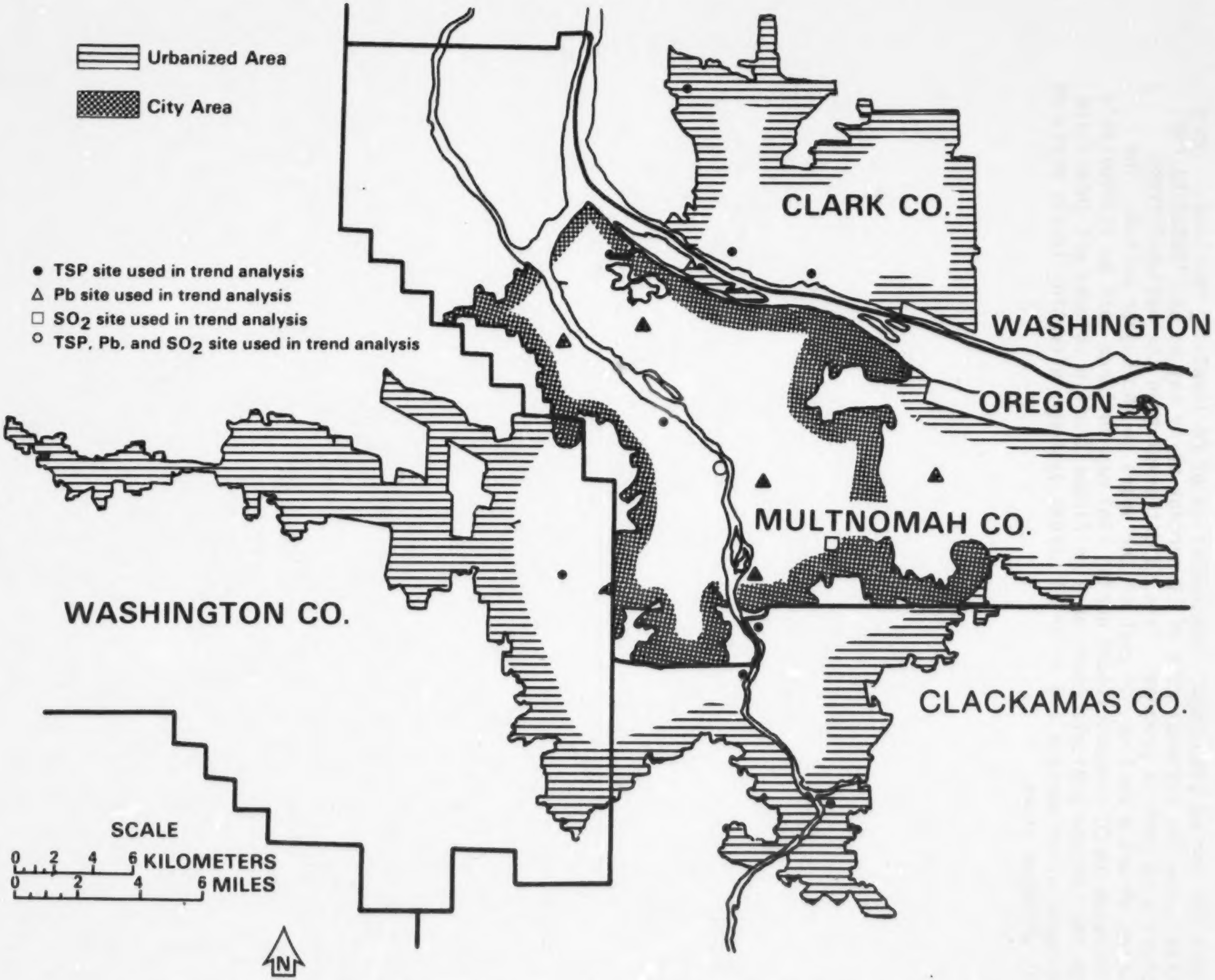

Urbanized Area
City Area
● TSP site used in trend analysis
△ Pb site used in trend analysis
□ SO₂ site used in trend analysis
○ TSP, Pb, and SO₂ site used in trend analysis
CLARK CO.
WASHINGTON
OREGON
MULTNOMAH CO.
WASHINGTON CO.
CLACKAMAS CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N

FIGURE 5-29. LOCATION OF TSP, Pb, AND SO_2 MONITORING SITES IN PORTLAND, OR-WA, 1980-1984.

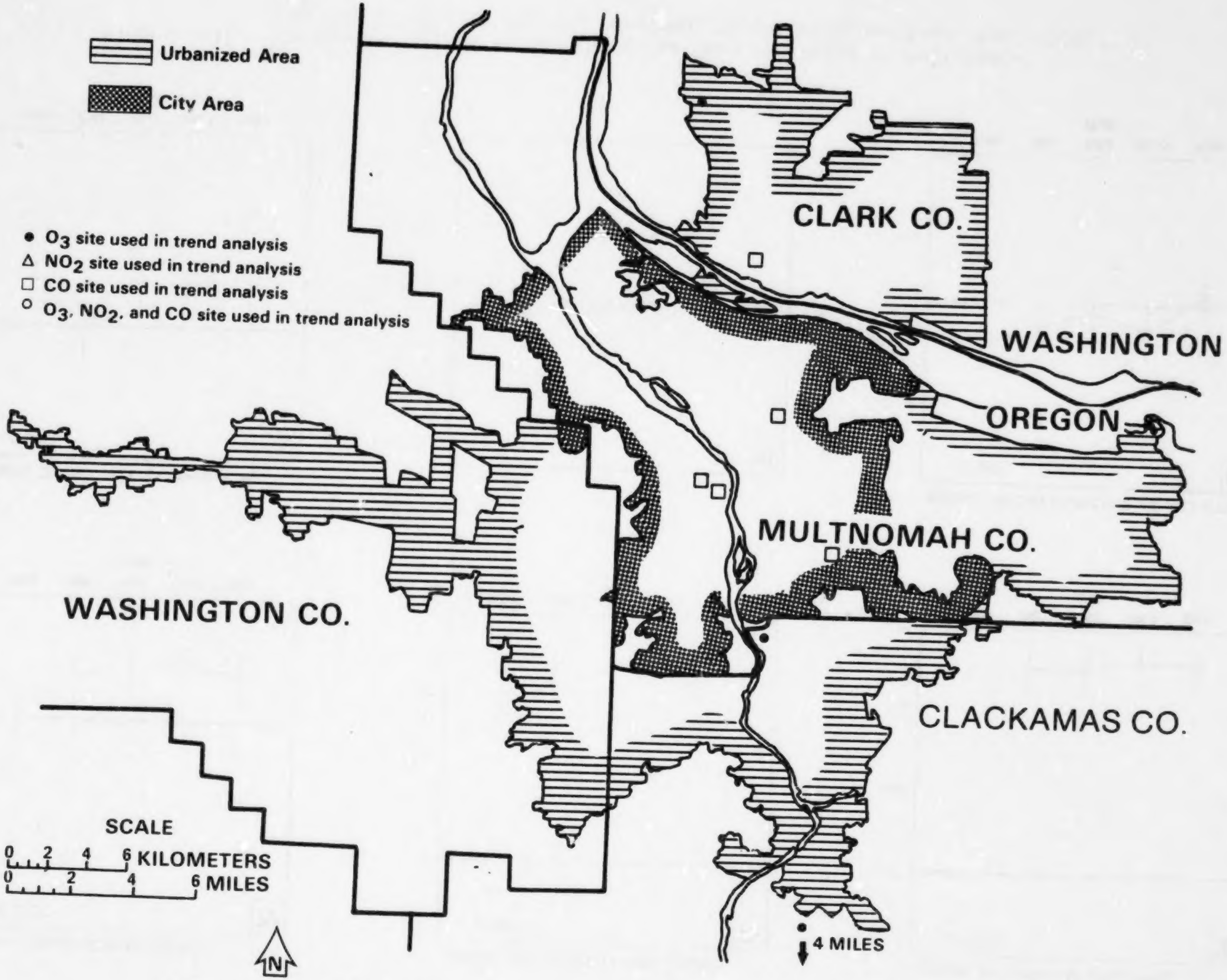

Urbanized Area
City Area
● O_3 site used in trend analysis
△ NO_2 site used in trend analysis
□ CO site used in trend analysis
○ O_3, NO_2, and CO site used in trend analysis
CLARK CO.
WASHINGTON
OREGON
MULTNOMAH CO.
WASHINGTON CO.
CLACKAMAS CO.
SCALE
0 2 4 6 KILOMETERS
0 2 4 6 MILES
N
4 MILES

FIGURE 5-30. LOCATION OF O_3, NO_2, AND CO MONITORING SITES IN PORTLAND, OR-WA, 1980-1984

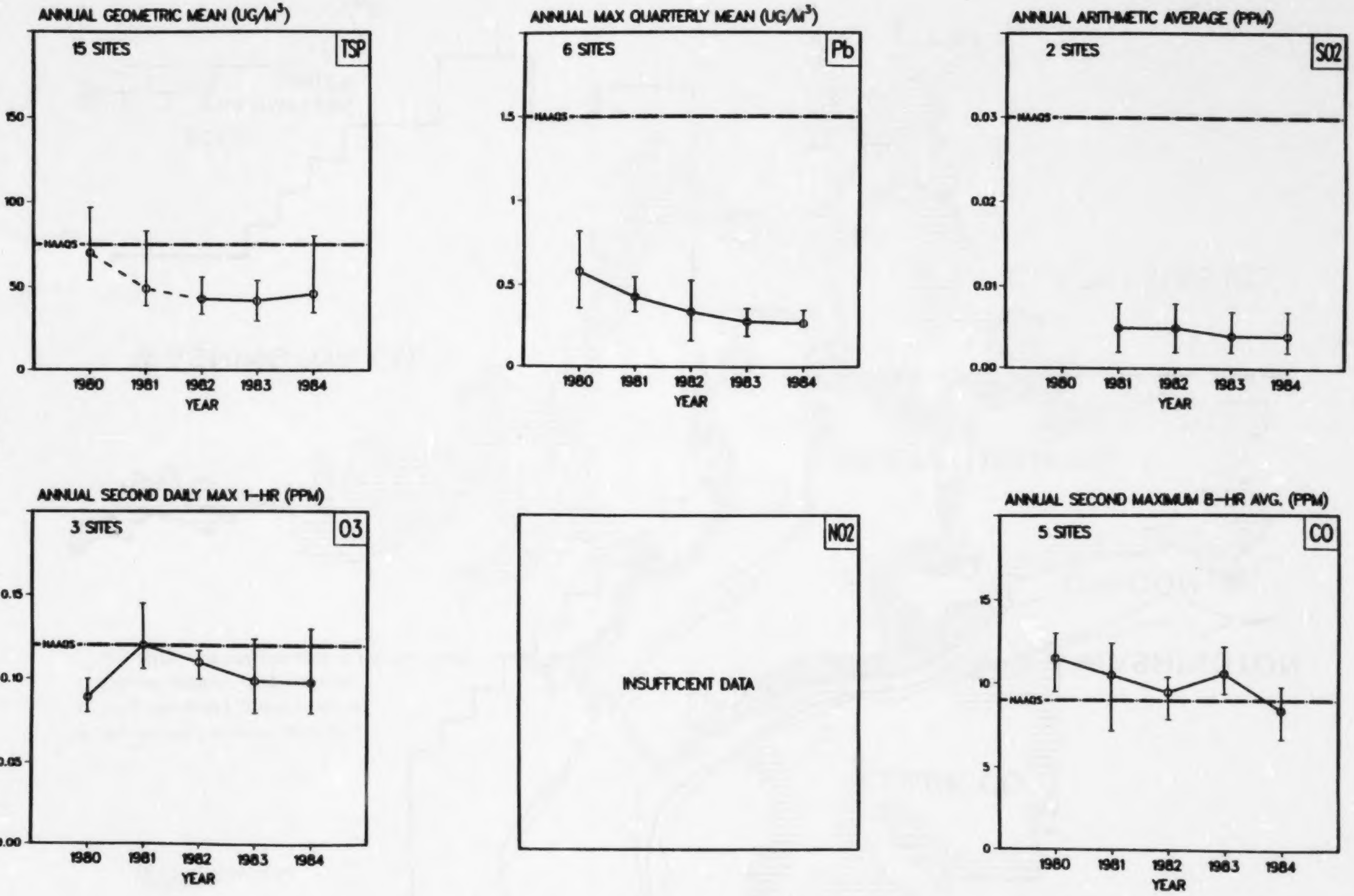


Figure 5-31. Air Quality Trends in the Composite Mean and Range of Pollutant-Specific Statistics for the Portland, OR-WA Urbanized Area, 1980-1984.

5.11 REFERENCES

1. 1980 Census of Population, U.S. Bureau of Census, PC 80-1, U.S. Government Printing Office, Washington, DC. December 1981.

2. Frank, N. H., "Nationwide Trends in Total Suspended Particulate Matter and Associated Changes in the Measurement Process," Proceedings of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. October 1984.

3. Johnson, T., J. Steigerwald, L. Wijnberg, J. Capel, and R. Paul, Analysis of Possible Causes of an Observed Decrease in Particulate Levels from 1981 to 1982. Prepared for EPA by PEDCo Environmental, Inc., Cincinnati, OH. April 1984.

4. Beloin, N., et al., 1983 Annual Report on Air Quality in New England, U.S. Environmental Protection Agency, Region I, Lexington, MA. July 1984.

5. Ostrowski, R., Philadelphia Air Management Services, Personal Communication with S. Sleva, March 1, 1985.

6. 1980 Annual Air Quality Report, Illinois Environmental Protection Agency, Division of Air Pollution Control, Springfield, IL.

7. 1981 Annual Air Quality Report, Illinois Environmental Protection Agency, Division of Air Pollution Control, Springfield, IL.

8. 1982 Annual Air Quality Report, Illinois Environmental Protection Agency, Division of Air Pollution Control, Springfield, IL. June 1983.

9. 1983 Annual Air Quality Report, Illinois Environmental Protection Agency, Division of Air Pollution Control, Springfield, IL.

10. 1984 Annual Air Quality Report, Illinois Environmental Protection Agency, Division of Air Pollution Control, Springfield, IL.

11. Sweitzer, T. A. and D. J. Kolaz, "An Assessment of the Influence of Meteorology on the Trend of Ozone Concentrations in the Chicago Area," Proceedings of the APCA/ASQC Specialty Conference, "Quality Assurance in Air Pollution Measurement," Boulder, CO. October 1984.

12. Goranson. S., U.S. Environmental Protection Agency, Chicago, IL, Personal Communication with D. Shipman, November 14, 1984.

13. McMullen, G., Houston Health Department, Personal Communication with N. Berg, March 11, 1985.

14. Colorado Air Quality Data Report 1984, Colorado Department of Health, Air Pollution Control Division.

15. Davidson, A., M. Hoggan, and P. Wong, Air Quality Trends in the South Coast Air Basin 1975-1984, South Coast Air Quality Management District, El Monte, CA. August 1985.

16. Davidson, A. and M. Hoggan, Air Quality Trends in the South Coast Air Basin 1975-1983, South Coast Air Quality Management District, El Monte, CA. November 1984.

17. Davidson, A. and J. Cassmassi, Ozone Reductions During Olympic Period due to Congestion Reducing Measures, Journal of the Air Pollution Control Association, March 1985.

18. 1984 Oregon Air Quality Annual Report, Oregon Department of Environmental Quality, Air Quality Control Division. July 1985.